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ASD INTERIM REPORT 7-678(IV)
May 1963

DEVELOPMENT AND STATISTICAL ANALYSIS EVALUATION OF MELTING AND TRANSVERSE PROPERTIES OF HIGH-STRENGTH (H-11 TYPE) STEEL

Joseph C. Truszynski

Jack A. Yoblin

LADISH CO.

Contract: AF33(600)-38767
ASD Project: 7-678

Interim Engineering Report No. 4
September 23, 1962 -- April 23, 1963

Four vacuum arc remelt process variations commercially available for the production of high-strength steel were statistically compared in terms of smooth and notch tensile test data developed from transverse and longitudinal specimens removed from 10-inch RCS press-forged billets. Of the four processes, (a) air melt-VAR, (b) air melt-degas-VAR, (c) air melt-double VAR, and (d) vacuum induction melt-VAR, investigated at a 300 Ksi ultimate strength level, the vacuum induction melt-VAR process provided the highest ductility and the most nearly uniform transverse and longitudinal strength and ductility. The air melt-VAR material ranked second in overall property response and uniformity, although significantly lower than that provided by the vacuum induction melt-VAR process. Air melt-degas-VAR and air melt-double VAR processes ranked third and fourth, respectively, but were not significantly different when compared with air melt-VAR property data.

METALLURGICAL PROCESSING BRANCH
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AIR FORCE MATERIALS LABORATORY

AFSC Aeronautical Systems Division
United States Air Force
Wright-Patterson Air Force Base, Ohio

DDC
JUN 11 1963

ABSTRACT - SUMMARY
Interim Engineering Report

ASD INTERIM REPORT 7-678(IV)
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DEVELOPMENT AND STATISTICAL ANALYSIS EVALUATION OF MELTING AND TRANSVERSE PROPERTIES OF HIGH-STRENGTH (H-11 TYPE) STEEL

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A total of 928 tensile specimens were removed from each of the four billets representing a separate vacuum arc remelt process variation. Sectioning was accomplished in a manner yielding comparable smooth and notched, transverse and longitudinal, surface, mid-radius, and center specimen blanks from each of 16 major sections long the length of the billet. Subsequent to testing, generated data was statistically analyzed to determine the influence upon mechanical properties of specimen type, direction, cross-sectional position, and location from top to bottom of the billet. From smooth specimens, yield and ultimate strength, per cent elongation, and reduction in area were analyzed. Notch ultimate strength and notch/smooth strength ratio values for the various combinations of conditions were also analyzed.

Statistical values reported include arithmetic mean, range, standard deviation, coefficient of variation, and standard deviation of the mean. Methods of evaluation employed included (a) preparation of control charts to illustrate the variation of mechanical property data from top to bottom of each billet (upper and lower control limits are given to indicate the relative degree of control afforded by each melting practice for each property and condition combination studied), (b) frequency distribution plots (histograms) prepared by an IBM 1620 computer to permit direct comparison of 144 separate groups of property data, and (c) miscellaneous charts and tables to effectively portray mean and standard deviation values for each data group.

A statistical-metallurgical evaluation of Phase III data indicates that the vacuum induction melt-VAR process possesses the capability of achieving one of the basic aims of the program (to be subsequently verified by testing closed-die-forged parts during Phase IV). The attainment of essentially isotropic properties is clearly feasible since transverse strength and ductility values closely approach those obtained from longitudinal specimens.

Notch/smooth ultimate strength relationships established for each remelt process variation at the 300 Ksi strength level, however, evidence considerable within-heat variation, primarily because of the sizable variation in notch strength values. Although mean values for the vacuum induction melt-VAR process N/S ratio exceeded average values for every comparable specimen direction and location in the other three processes, in no case did any average value equal or exceed unity at the strength level tested. Consequently, notch sensitivity must be considered a governing criterion in the design of H-11 steel components at this strength level.

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FOREWORD

This Interim Engineering Report covers the work performed under Contract AF33(600)-38767 from September 23, 1962 to April 23, 1963. It is published for technical information only and does not necessarily represent the recommendations, conclusions, or approval of the Air Force.

The Contract with Ladish Co., Cudahy, Wisconsin, was initiated under Aeronautical Systems Division Project 7-678 to investigate and determine the effect of melting and hot reduction practices on transverse ductility of high-strength steel. It is being accomplished under the technical direction of Mr. A. J. Merkle of the Basic Industry Branch, ASRCTB, Manufacturing Technology Laboratory, Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio.

The testing program and statistical evaluation are being accomplished under the auspices and technical direction of Ladish Co. Metallurgical Department. Mr. Joseph C. Truszynski is project engineer, Mr. Carl Lugar is Coordinator of Mechanical Testing, and Mr. Jack A. Yoblin, Director of the Research and Development Division of the Metallurgical Department, is project director. Contract administration and Governmental liaison is under the direction of Mr. Charles Burley, Jr., Director, Government Relations Division. Report editing was provided by Mr. W. R. Semrou, Technical Writer, Metallurgical Department.

The primary objective of the Air Force Manufacturing Methods Program is to increase producibility, and improve the quality and efficiency of fabrication of aircraft, missiles, and components thereof. This report is being disseminated in order that methods and/or equipment developed may be used throughout industry, thereby reducing costs and giving "MORE AIR FORCE PER DOLLAR."

Your comments are solicited on the potential utilization of the information contained herein as applied to your present or future production methods. Suggestions concerning additional Manufacturing Methods development required on this or other subjects will be appreciated.

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PRODUCTION REVIEW

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I. INTRODUCTION

Contract AF33(600)-38767 was awarded to Ladish Co. to determine the optimum steel producing process for the production of sound high-strength forging stock with uniform longitudinal and transverse ductility, and to subsequently test the selected process by making closed-die forgings. Program objective is a production process for forged parts with increased overall strength and ductility to reduce weight and increase functional effectiveness of aerospace vehicle components. Forged parts are to be produced and tested in Phase IV. In Phase III, the Contractor's objective has been to determine the effects of variations in the mill production process (vacuum arc remelting) which was statistically demonstrated in Phase II to offer the greatest potential for achievement of program objectives.

Interim Engineering Report No. 4 describes the work accomplished in the final portion of Phase III. Activity covered is that performed subsequent to the receipt of press-forged billet material produced by four commercially-available vacuum arc remelt process variations which were selected at the beginning of the phase as candidate mill practices suitable for evaluation as to their effectiveness in improving transverse ductility at ultrahigh-strength levels. Thus, the basic purpose of this phase has been to determine the effect of the variations of the vacuum arc remelt process which was selected in Phase II by virtue of its ability to provide transverse ductility markedly superior to that found in steel which has been electric furnace air melted and statically cast.

Vacuum melting technology has advanced rapidly in recent years. The improved reliability and higher quality of vacuum arc remelted materials is evidenced by its widespread acceptance and use in critical parts of missiles, jet engines, high-performance bearings, and other similar applications requiring high-quality forgings. Improvement is attributed to: 1) decreased gas content, 2) smaller and more uniformly distributed nonmetallic inclusions, and 3) decreased segregation due to rapid, progressive, controlled solidification.

The average degree of improvement in transverse ductility provided by vacuum arc remelted material when compared to conventionally-air melted H-11 steel was established in Phase II by means of a comprehensive statistical analysis of nearly 5000 sets of transverse tensile test data.

During Phase II, over 4000 sets of data from specimens in a strength range of 280,000 to 300,000 psi were obtained from six mills and Contractor's records. Data represented more than 500 individual heats, both melting practices (air melt and vacuum arc remelt), varying degrees of hot work as indicated by a range of billet sizes from 4-inch through 24-inch square, and two specimen locations (mid-radius and center). To supplement this data, the Contractor performed additional tests on samples from 44 heats of air melted, vacuum degassed, and vacuum arc remelted material. Specimens were prepared from full cross section billet material in a size range of 8-inch through 24-inch square, inclusive. Three specimen locations

(surface, mid-radius, and center) were involved in these tests, and all 528 specimens were heat treated to provide a minimum strength level of 300,000 psi.

The average ductility of remelt material as measured by per cent reduction of area of transverse specimens taken from mid-radius locations in billet material heat treated to an ultimate strength range of 280 to 300 Ksi was determined to be 20.6 per cent, or 75 per cent greater than comparable air melt ductility of 11.8 per cent. The even greater difference in mean ductility values for specimens taken from center-of-billet locations (air melt: 6.3 per cent; vacuum arc remelt: 19.6 per cent reduction of area) is attributed to the lack of soundness and the higher nonmetallic inclusion content generally associated with the center location in air melt material, particularly in the larger cross sections. For both mill practices, as billet size increased, average ductility decreased and displayed more variation from specimen to specimen; however, the rate of decrease was less pronounced in remelt than in air melt material. Both strength and ductility values were considerably more uniform in remelt material, irrespective of billet size or test location. In general, strength and ductility tended to diminish from surface to mid-radius to center location, except that the mid-radius ductility average in air melt material heat treated to a minimum strength level of 300 Ksi was determined to be even slightly lower than the comparable air melt average from center specimens. Considerable variation in properties between mills and billet sizes was observed.

The presence of areas of inherently low and varied transverse ductility found in hot-worked billets of air melted, statically-cast aircraft-quality steel should be recognized as a possible limiting factor for designers of high-strength steel aircraft and missile components, particularly at high strength levels where ductility falls off and becomes increasingly erratic. Notch tensile strength variation also dictates caution, since at high ultimate strength levels, notch tensile strength values are frequently lower than smooth specimen yield strength values. As a consequence, the possibility exists that failure of high-strength steel parts may be frequently the result of inadequate ductility rather than inadequate strength. In the light of such findings, the advisability of evaluating steel produced by advanced melting and processing methods for high-strength applications becomes even more apparent.

Since variables affecting material quality have the most pronounced effect on directional properties of steel at high strength levels, it therefore follows that improved control of variables which contribute to that effect must be attained if the benefits of high-strength materials are to be fully realized. Use of cleaner and more homogeneous material suggests itself as a practicable method for reducing the effect of directionality on mechanical properties of steel as demonstrated by the improvement realized by vacuum arc remelting of H-11 steel over conventional air melting. The resulting effect of comparable hot working on mechanical properties of each material was undeniably significant.

Interim Engineering Report No. 4, then, describes the statistical evaluation of mechanical property data generated from 10-inch square press-forged billets of H-11 steel melted by the following remelt process variations: a) air melt-vacuum arc remelt, b) air melt-vacuum degas-vacuum arc remelt, c) air melt-double vacuum arc remelt, and d) vacuum induction melt-vacuum arc remelt.

II. MATERIAL PROCUREMENT AND PROCESSING

A. Selection of Process Variations

Recently published technical literature reviewed in Interim Engineering Report No. 3 has substantiated that the improvement of mechanical properties in existing alloys cannot be dissociated from ingot solidification phenomena, and the frequency, size, shape, and distribution of nonmetallic inclusions.

Since each of the vacuum processes reviewed possessed certain inherent advantages and disadvantages of varying degree, it seemed logical that the result of combining or duplexing the processes should definitely promote a more favorable end product.

From the standpoint of their current level of development, and compatibility with the scope and requirements of the Contract, the only vacuum processes which appeared worthy of consideration were vacuum degassing, vacuum induction melting, and vacuum arc remelting. Although extremely promising, electron beam melting, for example, was still considered to be in an early stage of commercial development. Similarly, the availability of powder metallurgy electrodes for use in vacuum arc remelting nad not advanced sufficiently to warrant inclusion in this program. None of the other melting processes or modifying techniques reviewed appeared to have sufficient immediate potential for commercially producing ingot sizes and tonnages required in current production applications.

Of the three vacuum processes, namely, vacuum degassing, vacuum induction melting, and vacuum arc remelting, a total of four process combinations were selected for the purpose of determining the optimum melting practice. These were:

1. Air Melt-Vacuum Arc Remelt,
2. Air Melt-Double VAR,
3. Air Melt-Vacuum Degas-VAR, and
4. Vacuum Induction Melt-VAR.

Table I is a comparison of methods of vacuum melting and degassing which provided an advance indication of the magnitude of improvement to be expected from several duplex processes.

Test results with the air melt-VAR material were recognized as essential to provide a base line for comparison of the relative degree of improvement obtainable from the other process variations. Although much property data for this remelt process had been compiled and extensively studied in Phase II, the preponderant portion of such data represented material heat treated to a 280 to 300 Ksi strength level. Of the billet samples from 29 heats which had been treated to a minimum strength of 300 Ksi, considerable variation was manifest with respect to quality, sample origin within the billet, mill processing procedures, and as-received condition. This was as expected, since Phase II was essentially a comprehensive study to determine the current state-of-the-art for transverse ductility. Exclusion of data from discrepant material would have tended to defeat the requirement of establishing existing

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TABLE I

COMPARISON OF DIFFERENT METHODS OF VACUUM MELTING AND DEGASSING*

METHOD		MELTING VARIABLES: TEMPERATURE (°F)	MELTING VARIABLES: PRESSURE	MELTING VARIABLES: TIME METAL MOLTEN	PRODUCT CHARACTERISTICS: HOT WORKABILITY	PRODUCT CHARACTERISTICS: GAS CONTENT (PPM)	PRODUCT CHARACTERISTICS: CLEANLINESS	PRODUCT CHARACTERISTICS: SEGREGATION	PRODUCT CHARACTERISTICS: PHYSICAL PROPERTIES
Air Melting		2500 - 3100	1 Atmosphere	2 Hours to 3 Hours	Poor to Fair	H_2 4- 20 O_2 10-150 N_2 30-500	Fair	Normal	Normal
Vacuum Degassing		2500 - 3100	Melting: 1 Atmosphere Degassing: 0.5-10 mm	1/2 Hour to 4 Hours (for 40 to 150 tons of steel)	Fair to Good	H_2 1- 4 O_2 10- 60 N_2 40-120	Fair to Clean	Normal	Improved by 5 - 50 Per Cent
Vacuum Induction Melting		2500 - 3100	1 to 100 Microns	1 Hour to 5 Hours	Good	H_2 < 1 O_2 4- 10 N_2 3- 50	Very Clean	Normal	Improved by 20 - 200 Per Cent
Vacuum Arc Remelting	From Air Melted Electrode	2500 - 8500	5 to 500 Microns	15 Minutes to 30 Minutes	Good	H_2 1- 2 O_2 6- 30 N_2 40-100	Clean	Relatively Free	Improved by 10 - 100 Per Cent
	From Vacuum Induction Melted Electrode				Very Good	H_2 < 1 O_2 1- 5 N_2 2- 20	Extremely Clean		Improved by 30 - 300 Per Cent

* After A. M. Askoy, Vacuum Metals Corporation

capability, and therefore, Phase II material tested by the Contractor was not subjected to prior acceptance testing. In Phase III, however, it was desirable that data be generated from only the highest quality, commercially-available material. Accordingly, Phase III steel was ordered and acceptance tested in accordance with stringent chemical and metallurgical requirements which were selected in part on the basis of Phase II findings.

The air melt-vacuum degas-VAR combination was selected for inclusion in the investigation along with the other three combinations of vacuum processes which had been originally proposed since it was considered to afford an economically desirable electrode quality level generally above that of air melt, but lower than that of the VAR or vacuum induction melted electrodes. The precise quality level obtainable was recognized as depending greatly upon the effectiveness of the specific degassing unit, the type of steel being melted, and the particular quality advantages under consideration.

Finally, in establishing the particular sequence for each combination of processes, it seemed only logical to end with VAR because of its inherent advantages associated with progressive solidification. This sequence provides an ingot free of normal defects such as center looseness and shrinkage cavities resulting from static casting. In all four of the combinations evaluated, initial electrodes were prepared from statically-cast ingots. It was anticipated that subsequent vacuum arc remelting

would result in the elimination of the undesirable defects and thus provide a much more uniform and reliable end product.

Through statistical evaluation of the strength-ductility test results of the four metal processing combinations, the intention was to ascertain the optimum metal processing technique which, when applied to high-strength steels such as H-11, would contribute most to the production of forging material with isotropic or nearly isotropic properties.

B. Acceptance Requirements

Material acceptance requirements for Phase III material (adjusted on the basis of information derived from the statistical evaluation of vacuum arc remelted material in Phase II) were as follows:

Chemistry:	Carbon	0.38/0.43 (Aim 0.39/0.42)	+0.02	-0.00
	Manganese	0.20/0.30	+0.00	-0.05
	Phosphorus	0.010 Max.	+0.002	
	Sulfur	0.010 Max.	+0.002	
	P + S	0.015 Max.	+0.002	
	Silicon	0.75/0.90	+0.00	-0.05
	Chromium	5.00/5.25	+0.10	-0.05
	Molybdenum	1.20/1.40	+0.05	-0.05
	Vanadium	0.45/0.55	+0.02	-0.02

Magnetic Particle Inspection: AMS-2300.

Macroetch: 3 or better based on Ladish Co. Freckle Rating Chart.

Mechanical Properties: To be based on 0.505" tensile specimens, two (2) each, top and bottom, while maintaining a stress rate of 70,000-90,000 psi/minute to failure at mid-radius location.

Ultimate Strength (Ksi) ..... 300 to 330

Transverse Reduction of Area (per cent) .... 4 Minimum
6 Average (4 tests)

Grain Size: 7 or finer per ASTM E112-58T.

Microstructure: Carbides must be fine and uniformly distributed with no evidence of segregation.

Heat Treat Condition: Material shall be furnished in a machinable condition having a hardness not higher than 235 BHN.

Rejection: Material not conforming to the above requirements at top and bottom ingot locations will be rejected.

C. Selection of Supplier

Material acceptance requirements were incorporated into inquiries sent to four of the six mills which participated in Phase II. Selection of these four as potential suppliers of Phase III material was based upon an analysis of Phase II performance. Replies from each of the four mills queried were evaluated with respect to exceptions taken to requirements, availability of necessary facilities, relative performance in Phase II (considered as indicative of respective capability), promised delivery, and price. The cost of material ultimately procured ranged from $0.85 per pound for the air melt-vacuum arc remelt billet to $3.60 per pound for the vacuum induction melt-vacuum arc remelt billet.

The selected mill provided the advantage of the highest transverse ductility (average per cent reduction of area) and the lowest average variation (overall standard deviation) developed statistically in Phase II from mill-supplied and in-house data for vacuum arc remelt material. This combination of highest average ductility together with least variation, or spread, between high and low values was interpreted as indicative of the maximum currently-available degree of uniformly good transverse ductility in remelt material. Thus, considerable assurance was established that the vacuum arc remelted material procured

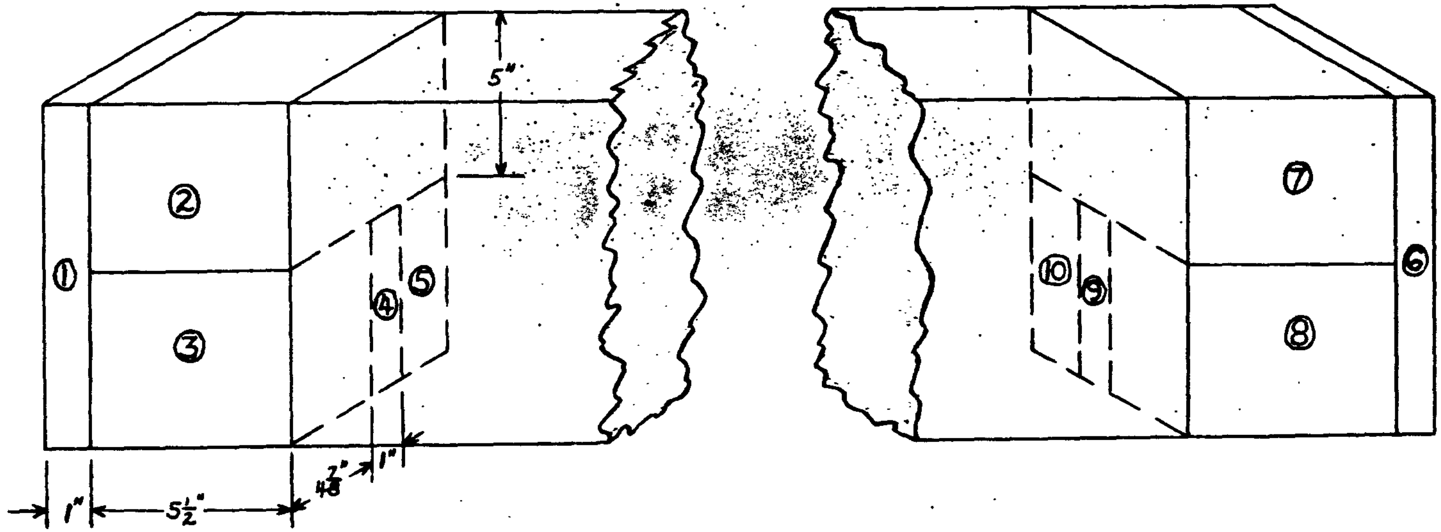
in Phase III would be representative of the highest quality currently available.

An added factor favoring the selected mill was in-house capability to produce all four process variations investigated by the statistical evaluation of generated property data, thereby obviating concern over process variables peculiar to different mills.

A further advantage was seen in the fact that it was possible for three of the four process variations to be developed from a single master air melt heat. The fourth, vacuum induction melt-vacuum arc remelt, had, of necessity, to originate as a separate heat. Thus, the opportunity was presented to further substantially reduce the influence of qualitative differences known to be present in air melt heats as a variable affecting mechanical properties apart from variation of the duplex process.

D. Acceptance Testing

Upon receipt of ten-inch RCS press-forged billet material produced by each of the four vacuum arc remelt process variations under investigation, ultrasonic inspection was performed. Subsequently, the Contractor removed five sections of steel from the top and bottom extremities of each billet to establish compliance with metallurgical acceptance requirements. Figure 1 illustrates the acceptance test sectioning plan and lists the types of tests for which each section was utilized.



SECTION NUMBER BILLET TOP	SECTION NUMBER BILLET BOTTOM	UTILIZATION OF MATERIAL
1	6	Transverse Macroetch, Chemistry, Microstructure, Microcleanliness, Grain Size Determination
2	7	Transverse Tensile Test Specimens
3	8	Stepdown Bars for Magnetic Particle Inspection
4	9	Longitudinal Tensile Test Specimens
5	10	● Longitudinal Macroetch

●

FIGURE 1

SECTIONING DIAGRAM FOR ACCEPTANCE TEST MATERIAL

After the inner face of Sections 1 and 6 were polished, etched in concentrated hydrochloric acid at 170°F, and photographed to establish the transverse macrostructure of the full cross section of each billet top and bottom, Sections 1 and 6 were used to determine (a) chemical composition percentages at surface, mid-radius, and center locations, (b) surface, mid-radius, and center microcleanliness, (c) mid-radius grain size, and (d) mid-radius microstructure at magnifications of 100 and 1000.

Acceptance test Sections 2 and 7 each yielded five surface, five mid-radius, and five center specimens for transverse tensile testing. These were divided into groups of six consisting of a single surface, mid-radius, and center specimen from each end of the billet. Heat treatment of each group was varied with respect to tempering temperature, which ranged from 900 to 1000°F in increments of 25°F. Tempering temperatures were varied to establish the optimum treatment for each billet. Specimens were preheated at 1400°F (one hour at temperature), austenitized at 1850°F (one hour at temperature), fan air cooled while tumbling, triple tempered followed by still air cooling after each two-hour temper (at temperature), stress relieved at 650°F for three hours, and still air cooled to room temperature.

A single longitudinal tensile specimen was removed from the surface, mid-radius, and center locations of Sections 4 and 9. Heat treatment for longitudinal tensile specimens was the same as for transverse specimens, except that all six longitudinal specimens were given a 925°F triple temper.

Sections 3 and 8 were forged down to a four-inch diameter round, prepared into stepdown bars, and magnetic particle inspected per AMS-2300A. Heat treatment after rough machining included a double temper at 1200°F for four hours each. Inspected surfaces were finish machined to 32 RMS.

Longitudinal macroetches from surface to billet center were prepared from Sections 5 and 10.

Acceptance test results for the air melt-vacuum arc remelt billet of H-11 steel were as follows:

Sonic Test:	Satisfactory
Macroetch:	Transverse Section from Top of Ingot -- Figure 2 Transverse Section from Bottom of Ingot -- Figure 3 Longitudinal Section from Top of Ingot and Bottom of Ingot -- Figure 4
Magnetic Particle Inspection:	(Forged stepdown bars processed per AMS-2300A) Frequency/Severity Rating at -- Top .00/.00 Bottom .00/.00
Microstructure:	See Figure 5
Microcleanliness:	(ASTM E45-51, Method "A") Surface, mid-radius, and center positions in cross section at top and bottom of billet exhibited predominantly oxide-type inclusions. Thin series = 1.0. Heavy series = 0.5. These ratings were exceeded only at the top mid-radius position where thin series = 1.5 and heavy series = 1.0.
Grain Size:	(Mid-radius position) Top ---Range 6-8, Predominant 6 Bottom-Range 6-8, Predominant 7

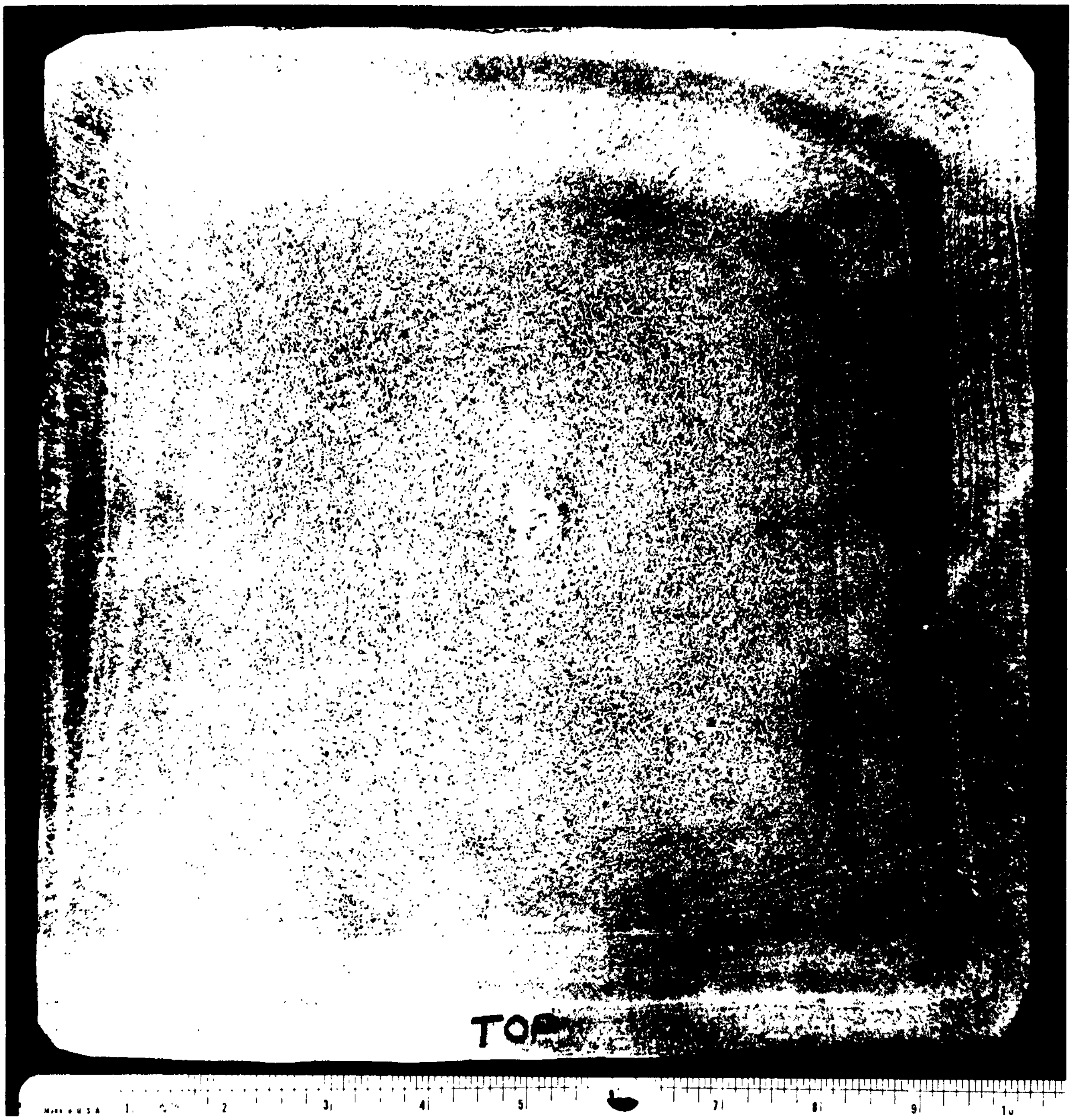


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FIGURE 2

TRANSVERSE MACROETCH OF BILLET TOP --
AIR MELT-VACUUM ARC REMELT HEAT NO. W-24341-1

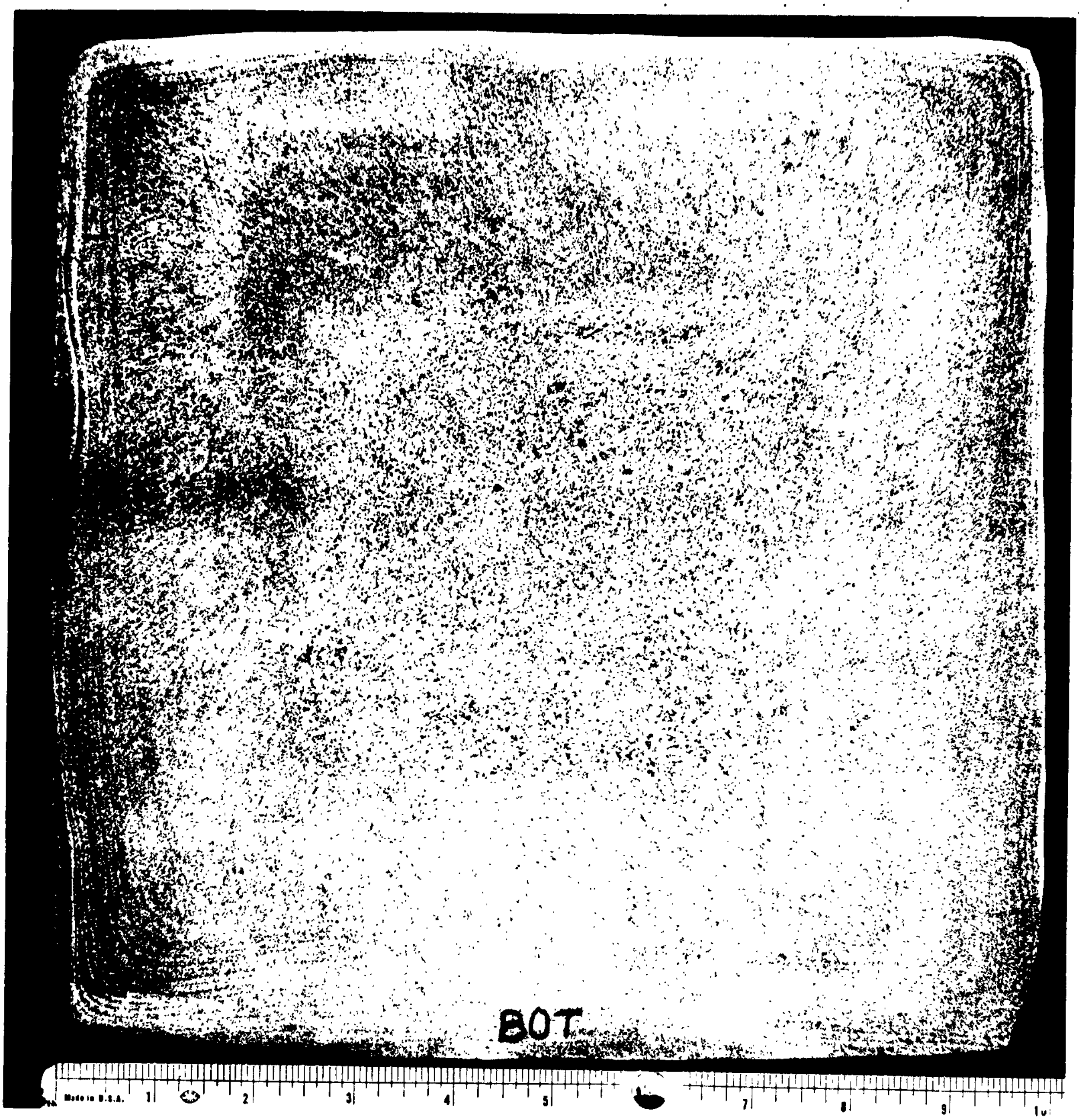

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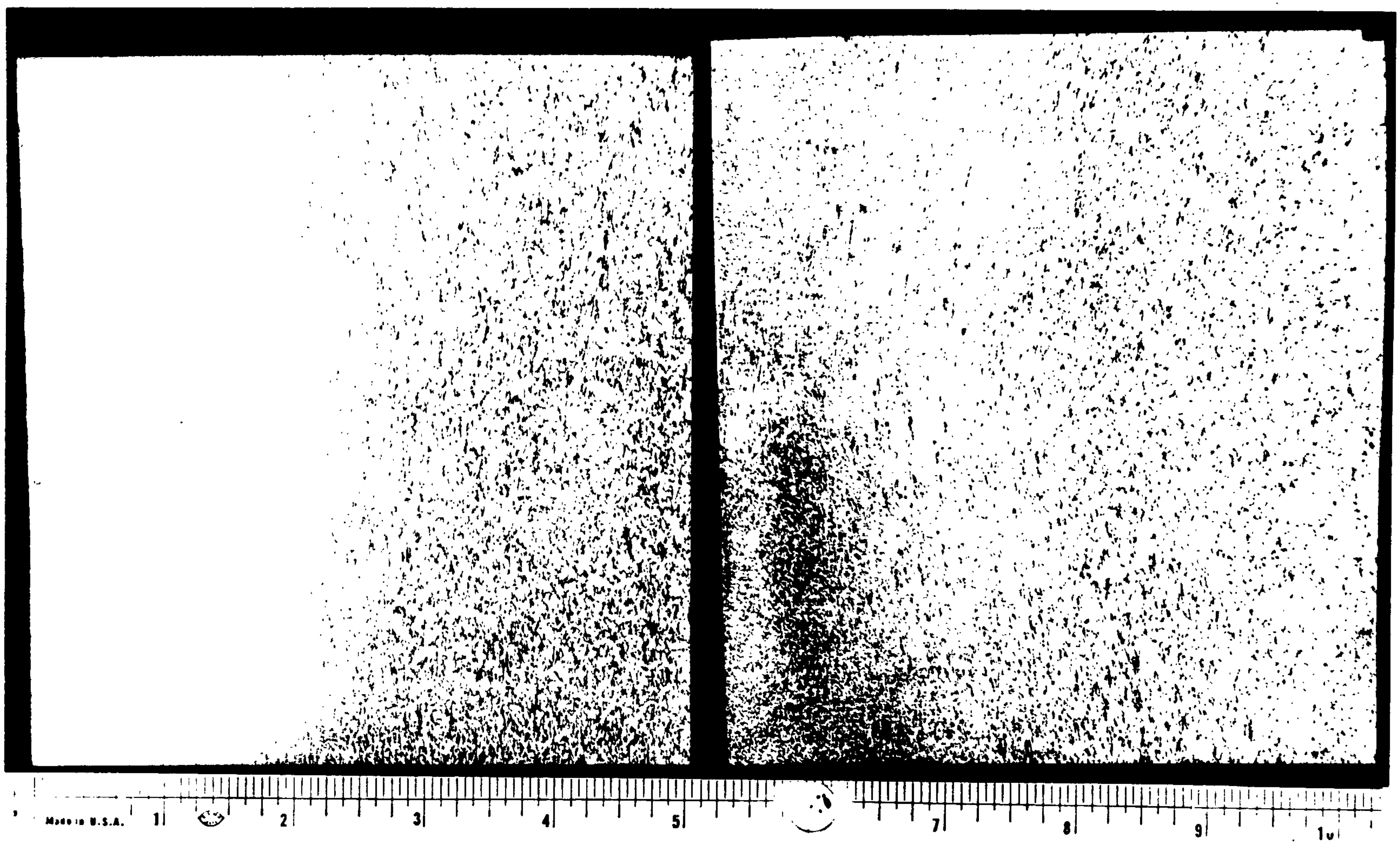
FIGURE 3

TRANSVERSE MACROETCH OF BILLET BOTTOM --
AIR MELT-VACUUM ARC REMELT HEAT NO. W-24341-1



Bottom Top

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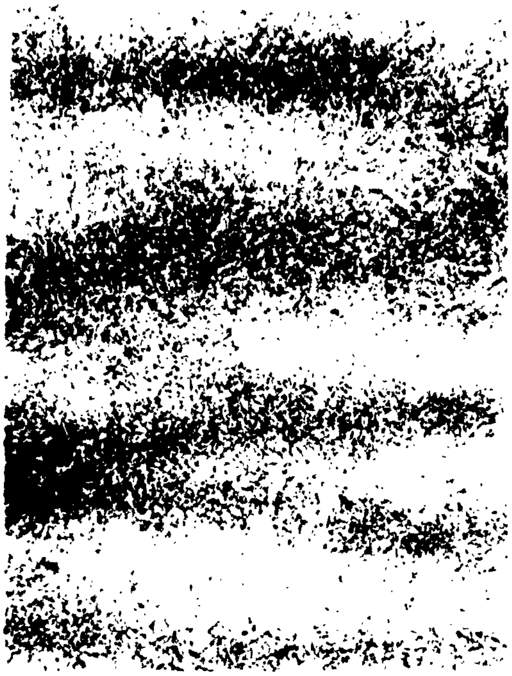
FIGURE 4

LONGITUDINAL MACROETCH AT BILLET TOP AND BOTTOM --
AIR MELT-VACUUM ARC REMELT HEAT NO. W-24341-1



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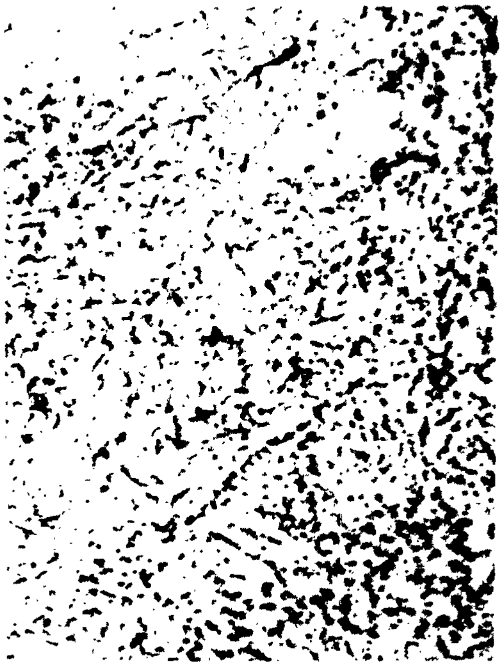


Top 100X

Top 1000X

Etchant: 4% Nital

C-2938

Bottom 100X

Bottom 1000X

FIGURE 5

MID-RADIUS MICROSTRUCTURE AT BILLET TOP AND BOTTOM --
AIR MELT-VACUUM ARC REMELT HEAT NO. W-24341-1

Chemistry:

Location	C	Mn	P	S	Si	Ni	Cr	Mo	Cu	V
Top-Surface	.39	.22	.007	.005	.76	.11	5.10	1.24	.08	.51
Top-Mid-radius	.42	.22	.007	.005	.76	.11	5.12	1.25	.08	.50
Top-Center	.40	.23	.007	.005	.78	.14	5.16	1.25	.08	.53
Bottom-Surface	.38	.22	.007	.005	.75	.12	5.07	1.21	.08	.52
Bottom-Mid-radius	.38	.22	.007	.005	.76	.11	5.06	1.22	.08	.50
Bottom-Center	.385	.22	.007	.005	.77	.11	5.08	1.21	.07	.52
Average (Ladish Co.)	.39	.22	.007	.005	.76	.11	5.09	1.23	.08	.52
Average (Mill)	.38	.23	.006	.005	.79		5.01	1.25		.54

Tensile Tests: (0.505-inch specimen, 7/8-inch thread)

Transverse Specimens -- 1850°F Austenitize, 900°F Triple Temper

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Surface	316,500	5.0
Top-Mid-radius	268,750	1.9
Top-Center	251,250	0.8
Bottom-Surface	298,500	5.8
Bottom-Mid-radius	296,800	4.7
Bottom-Center	288,000	3.2

Transverse Specimens -- 1850°F Austenitize, 925°F Triple Temper

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Surface	302,500	2.3
Top-Mid-radius	278,750	1.9
Top-Center	235,000	0.8
Bottom-Surface	301,500	4.7
Bottom-Mid-radius	297,500	4.0
Bottom-Center	280,800	2.4

Transverse Specimens -- 1850°F Austenitize, 950°F Triple Temper

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Surface	307,500	5.4
Top-Mid-radius	239,500	0.4
Top-Center	210,400	1.2
Bottom-Surface	302,500	12.1
Bottom-Mid-radius	300,000	6.2
Bottom-Center	294,400	3.2

Transverse Specimens -- 1850°F Austenitize, 975°F Triple Temper

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Surface	294,300	11.9
Top-Mid-radius	287,500	4.3
Top-Center	228,500	1.4
Bottom-Surface	290,000	8.1
Bottom-Mid-radius	286,500	7.7
Bottom-Center	282,500	3.5

Transverse Specimens -- 1850°F Austenitize, 1000°F Triple Temper

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Surface	283,500	21.6
Top-Mid-radius	286,500	3.2
Top-Center	255,500	1.2
Bottom-Surface	280,000	14.5
Bottom-Mid-radius	280,000	10.4
Bottom-Center	277,000	4.7

Longitudinal Specimens -- 1850°F Austenitize, 925°F Triple Temper

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Surface	314,300	16.7
Top-Mid-radius	295,600	2.4
Top-Center	263,050	2.4
Bottom-Surface	303,200	12.9
Bottom-Mid-radius	302,000	7.0
Bottom-Center	300,000	6.6

Acceptance test results for the air melt-degas-vacuum arc remelt billet of H-11 steel were as follows:

Sonic Test: Satisfactory

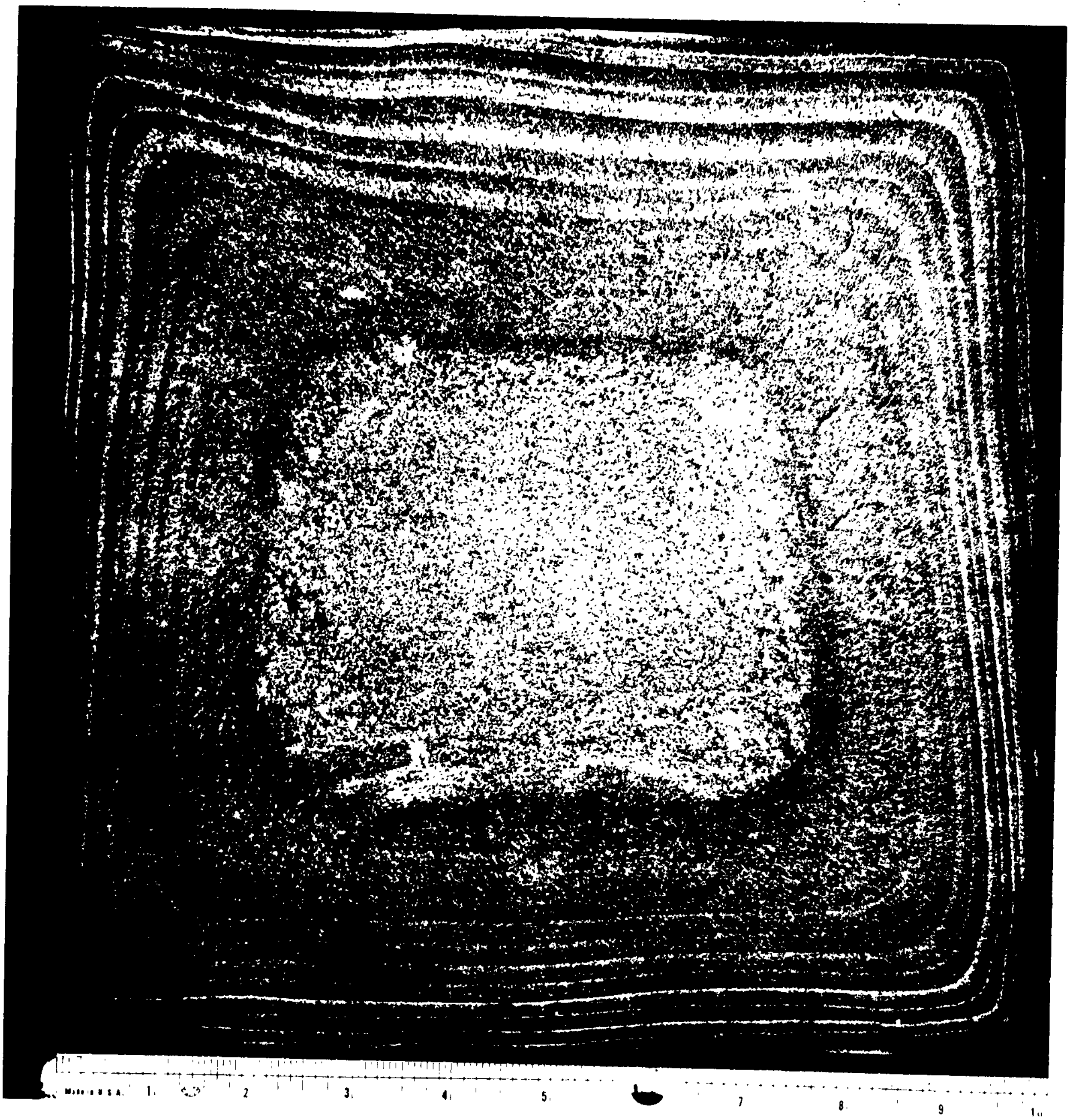
Macroetch:
Transverse Section from Top of Ingot -- Figure 6
Transverse Section from Bottom of Ingot -- Figure 7
Longitudinal Section from Top of Ingot and Bottom of Ingot -- Figure 8

Magnetic Particle Inspection: (Forged stepdown bars processed per AMS-2300A)
Frequency/Severity Rating at --
Top .02/.07
Bottom .00/.00

Microstructure: See Figure 9

Microcleanliness: (ASTM E45-51, Method "A")
Surface, mid-radius, and center positions in cross section at top and bottom of billet exhibited predominantly oxide-type inclusions. Thin series = 1.0. Heavy series = 0.5.

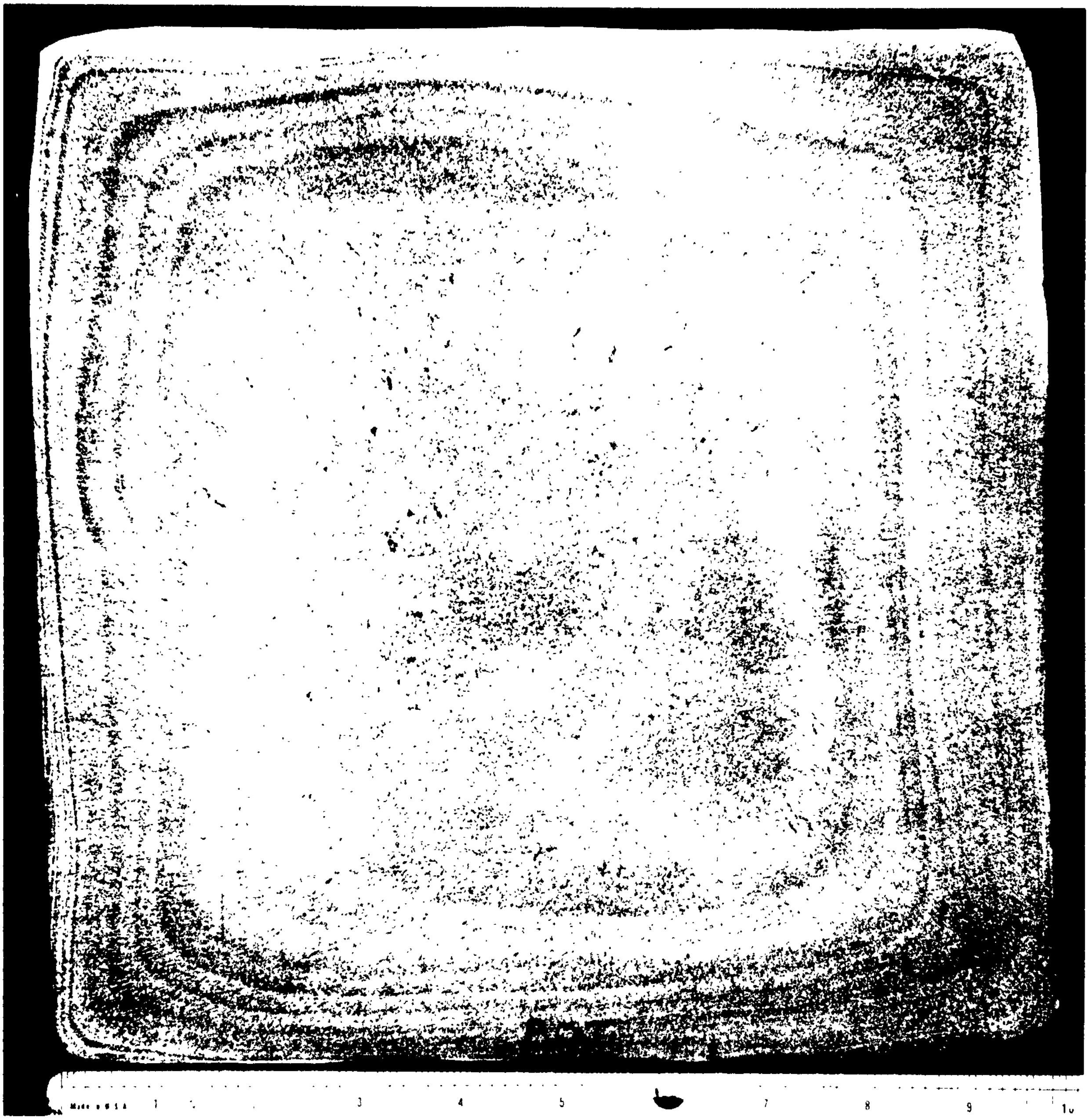
Grain Size: (Mid-radius position)
Top ---- Range 6-8, Predominant 7
Bottom - Range 6-8, Predominant 7



FI[illegible]URE [illegible]

[illegible] MACROETCH OF BILLET FOR --
IN [illegible]-VACUUM ARC [illegible] HEAT NO. W- [illegible] -7

[illegible]



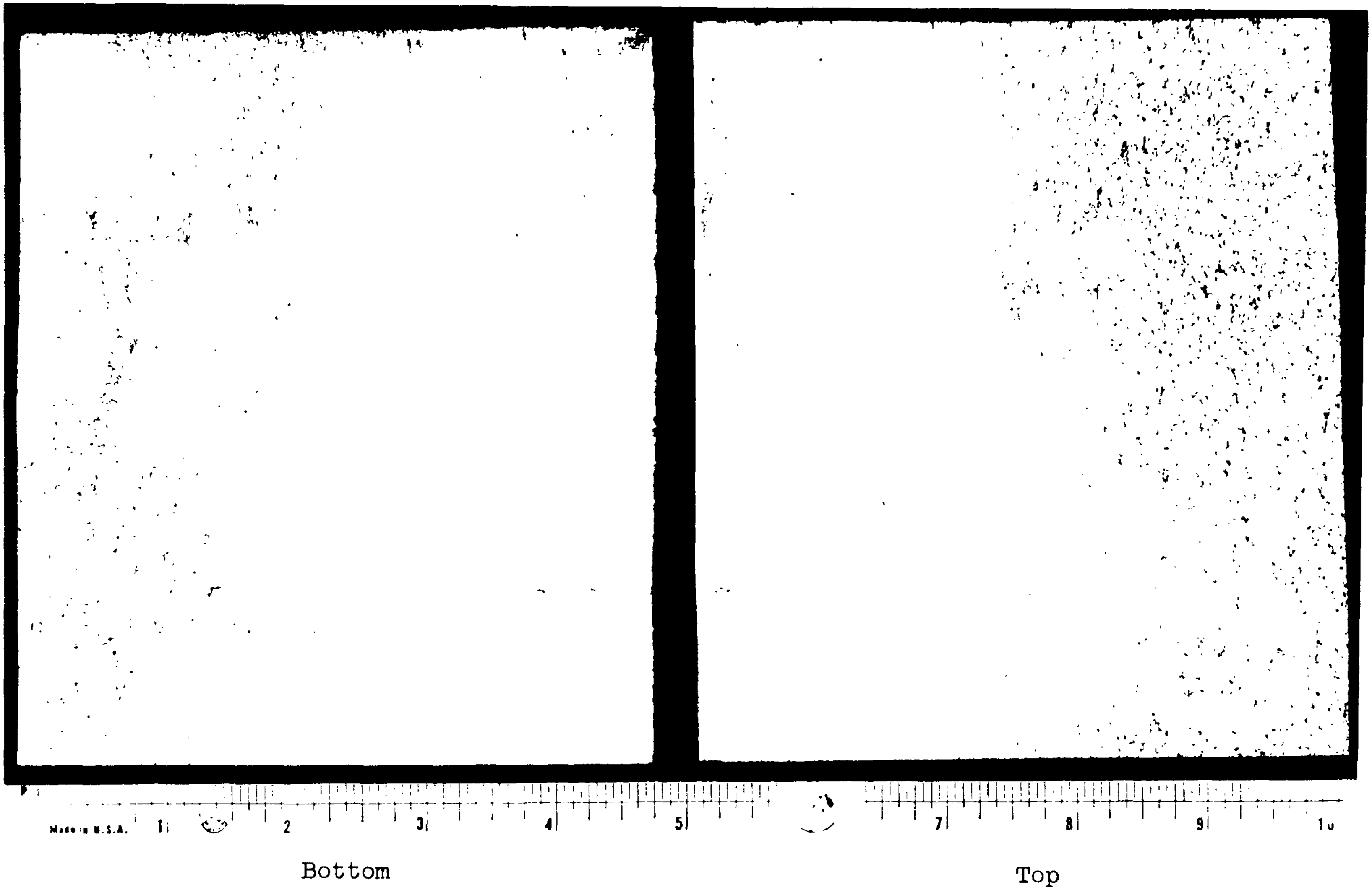


FIGURE 8

LONGITUDINAL MACROETCH AT BILLET TOP AND BOTTOM --
AIR MELT-DEGAS-VACUUM ARC REMELT HEAT NO. W-24342-V1

C-2943

Top 100X Top 1000X

Etchant: 4% Nital

C-2948

Bottom 100X Bottom 1000X

FIGURE 9

MID-RADIUS MICROSTRUCTURE AT BILLET TOP AND BOTTOM --
AIR MELT-DEGAS-VACUUM ARC REMELT HEAT W-24342-V1

Chemistry:

Location	C	Mn	P	S	Si	Ni	Cr	Mo	Cu	V
Top-Surface	.395	.22	.007	.005	.76	.12	5.10	1.22	.07	.51
Top-Mid-radius	.39	.23	.007	.005	.75	.12	5.09	1.22	.07	.57
Top-Center	.39	.23	.007	.005	.75	.10	5.05	1.22	.07	.48
Bottom-Surface	.365	.20	.007	.005	.75	.10	5.11	1.20	.07	.50
Bottom-Mid-radius	.38	.20	.007	.005	.79	.10	5.13	1.21	.07	.49
Bottom-Center	.39	.20	.007	.005	.75	.10	5.14	1.22	.07	.49
Average (Ladish Co.)	.39	.22	.007	.005	.76	.10	5.10	1.22	.07	.50
Average (Mill)	.38	.24	.006	.005	.77		5.00	1.26		.54

Tensile Tests: (0.505-inch specimen, 7/8-inch thread)

Transverse Specimens -- 1850°F Austenitize, 900°F Triple Temper

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Surface	307,100	6.7
Top-Mid-radius	303,750	5.4
Top-Center	288,200	4.0
Bottom-Surface	300,000	16.1
Bottom-Mid-radius	305,000	5.0
Bottom-Center	287,500	2.3

Transverse Specimens -- 1850°F Austenitize, 925°F Triple Temper

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Surface	298,750	3.5
Top-Mid-radius	293,200	3.2
Top-Center	298,800	4.7
Bottom-Surface	304,375	13.4
Bottom-Mid-radius	303,800	3.6
Bottom-Center	300,500	3.1

Transverse Specimens -- 1850°F Austenitize, 950°F Triple Temper

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Surface	303,900	5.9
Top-Mid-radius	308,200	7.8
Top-Center	296,250	3.9
Bottom-Surface	301,250	15.6
Bottom-Mid-radius	302,500	9.2
Bottom-Center	288,800	1.6

Transverse Specimens -- 1850°F Austenitize, 975°F Triple Temper

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Surface	297,500	7.0
Top-Mid-radius	300,000	5.8
Top-Center	291,800	5.2
Bottom-Surface	295,000	13.7
Bottom-Mid-radius	291,250	4.3
Bottom-Center	299,300	3.2

Transverse Specimens -- 1850°F Austenitize, 1000°F Triple Temper

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Surface	286,500	5.8
Top-Mid-radius	287,500	9.2
Top-Center	285,000	5.8
Bottom-Surface	283,500	28.2
Bottom-Mid-radius	281,000	15.2
Bottom-Center	288,500	5.0

Longitudinal Specimens -- 1850°F Austenitize, 925°F Triple Temper

Top-Surface	301,500	12.2
Top-Mid-radius	308,000	5.3
Top-Center	305,500	5.5
Bottom-Surface	302,500	14.8
Bottom-Mid-radius	302,200	8.2
Bottom-Center	308,750	3.5

Acceptance test results for the air melt-double vacuum arc remelt billet of H-11 steel were as follows:

<u>Sonic Test:</u> Satisfactory

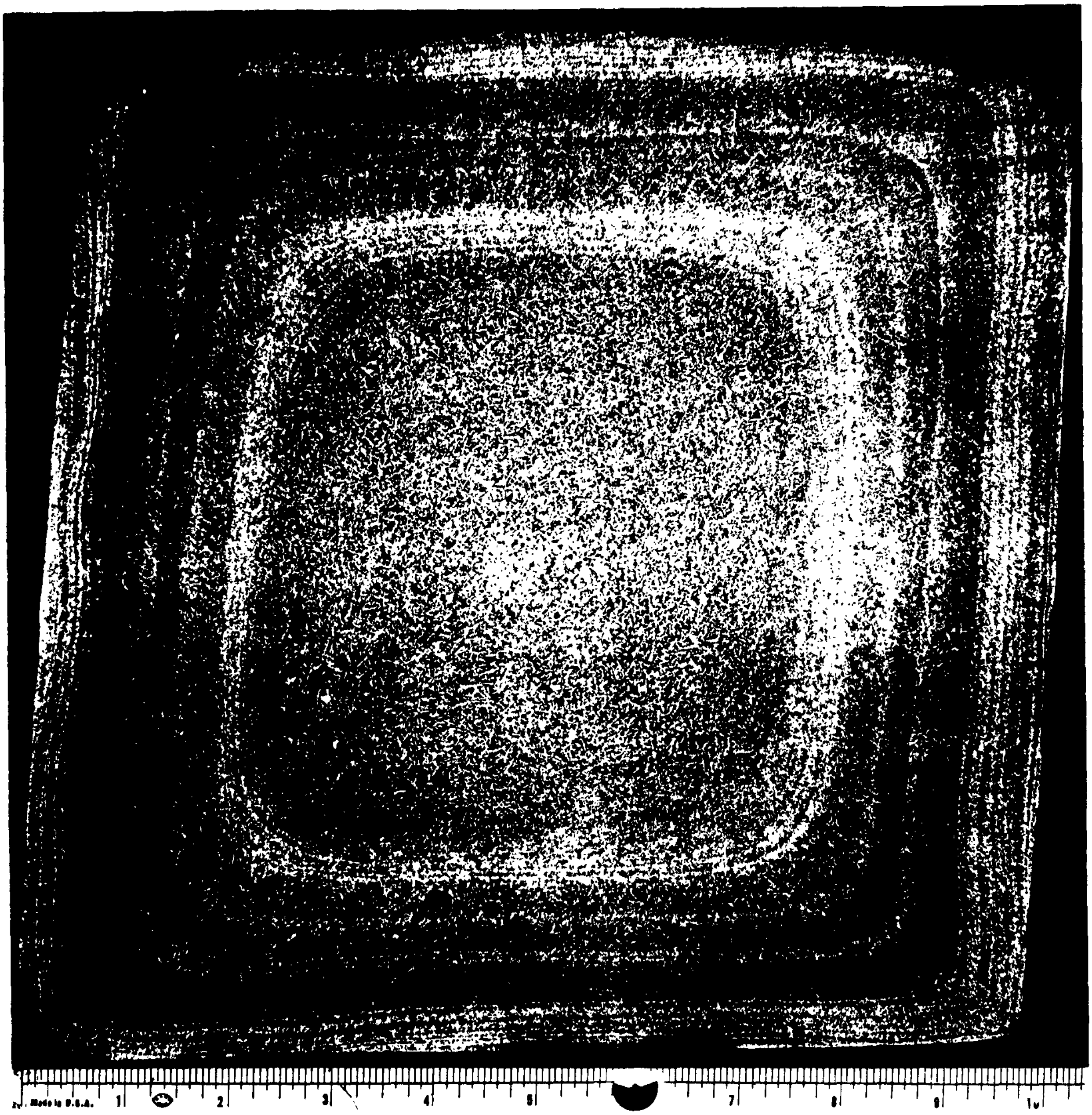
<u>Macroetch:</u> Transverse Section from Top of Ingot -- Figure 10
Transverse Section from Bottom of Ingot -- Figure 11
Longitudinal Section from Top of Ingot and Bottom of Ingot -- Figure 12

<u>Magnetic Particle Inspection:</u> (Forged stepdown bars processed per AMS-2300A)
Frequency/Severity Rating at --
Top .00/.00
Bottom .00/.00

<u>Microstructure:</u> See Figure 13

<u>Microcleanliness:</u> (ASTM E45-51, Method "A")
Surface, mid-radius, and center positions in cross section at top and bottom of billet exhibited predominantly oxide-type inclusions. Thin series = 1.0 to 1.5. Heavy series = 0.5.

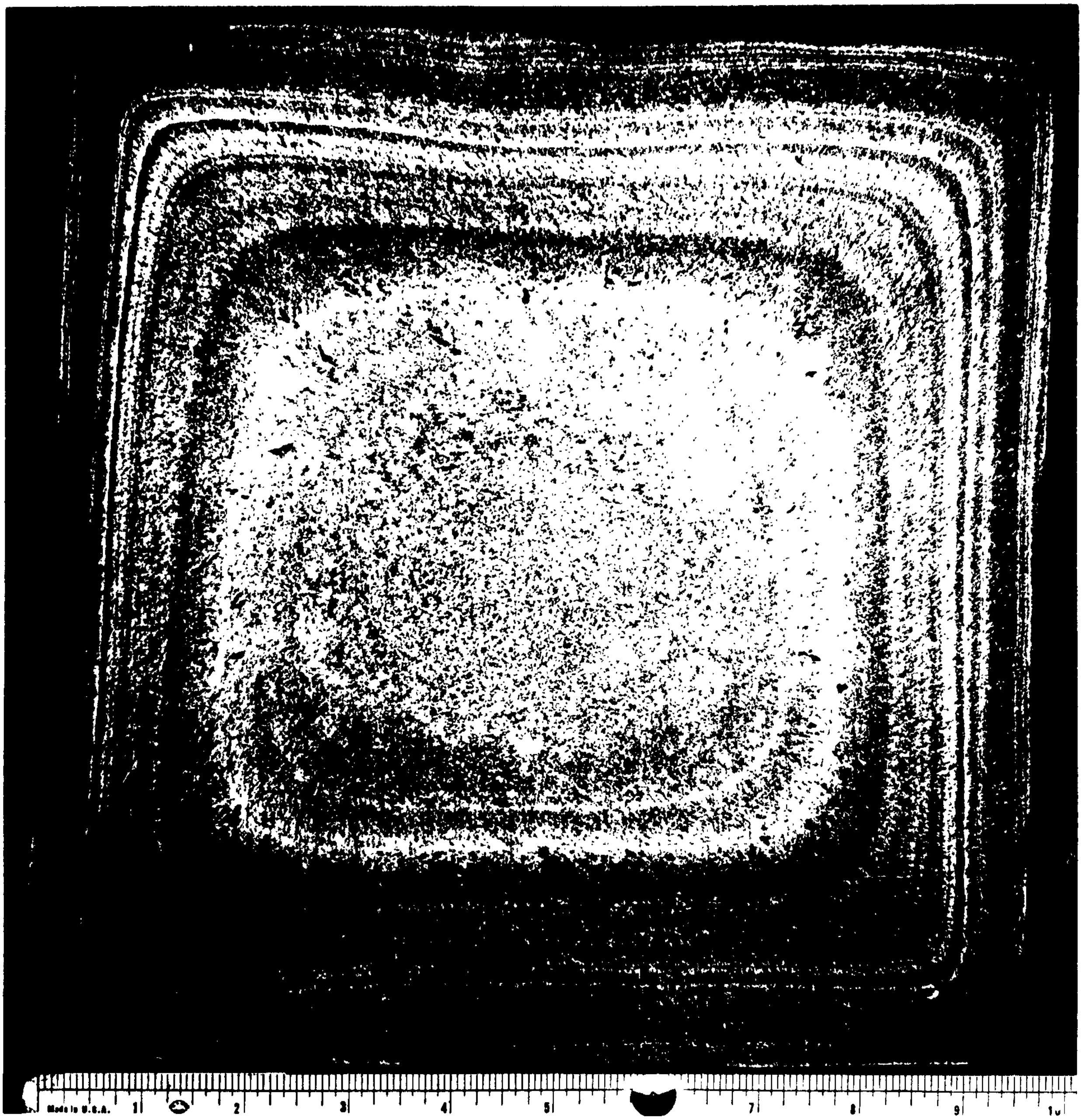
<u>Grain Size:</u> (Mid-radius position)
Top ---- Range 5-8, Predominant 7
Bottom - Range 6-8, Predominant 7



19975

FIGURE 10

TRANSVERSE MACROETCH OF BILLET TOP --
AIR MELT-DOUBLE VACUUM ARC REMELT HEAT NO. W-24341-2



19976

FIGURE 11

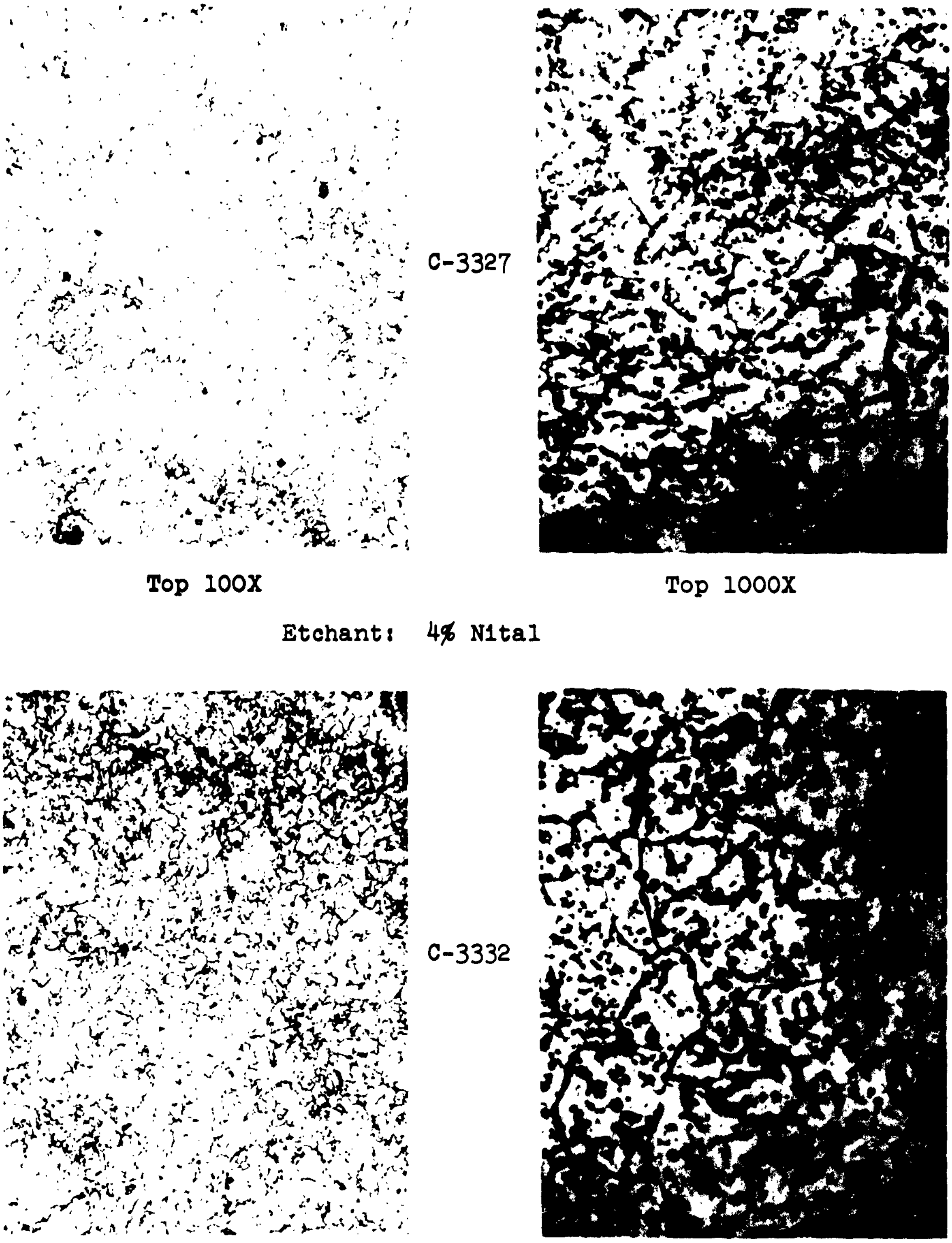
TRANSVERSE MACROETCH OF BILLET BOTTOM --
AIR MELT-DOUBLE VACUUM ARC REMELT HEAT NO. W-24341-2

19977

Top Bottom

FIGURE 12

LONGITUDINAL MACROETCH AT BILLET TOP AND BOTTOM --
AIR MELT-DOUBLE VACUUM ARC REMELT HEAT NO. W-24341-2



C-3327

Top 100X

Top 1000X

Etchant: 4% Nital

C-3332

Bottom 100X

Bottom 1000X

FIGURE 13

MID-RADIUS MICROSTRUCTURE AT BILLET TOP AND BOTTOM --
AIR MELT-DOUBLE VACUUM ARC REMELT HEAT W-24341-2

Chemistry:

Location	C	Mn	P	S	Si	Ni	Cr	Mo	Cu	V
Top-Surface	.40	.20	.010	.006	.76	.10	5.15	1.24	.07	.51
Top-Mid-radius	.40	.20	.010	.006	.74	.12	5.14	1.25	.07	.52
Top-Center	.41	.20	.010	.006	.73	.11	5.15	1.24	.07	.52
Bottom-Surface	.37	.20	.010	.006	.73	.10	5.10	1.23	.07	.52
Bottom-Mid-radius	.39	.29	.010	.006	.73	.10	5.12	1.24	.07	.52
Bottom-Center	.38	.29	.010	.006	.71	.09	5.10	1.22	.06	.50
Average (Ladish Co.)	.39	.22	.010	.006	.73	.10	5.12	1.24	.07	.52
Average (Mill)	.39	.20	.006	.005	.77		5.02	1.22		.55

Tensile Tests: (0.505-inch specimen, 7/8-inch thread)

Transverse Specimens -- 1850°F Austenitize, 900°F Triple Temper

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Surface	285,000	2.7
Top-Mid-radius	300,500	4.0
Top-Center	227,000	1.1
Bottom-Surface	289,300	2.0
Bottom-Mid-radius	280,300	4.4
Bottom-Center	269,200	2.0

Transverse Specimens -- 1850°F Austenitize, 925°F Triple Temper

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Surface	291,500	1.9
Top-Mid-radius	313,200	6.3
Top-Center	268,200	1.9
Bottom-Surface	296,250	4.3
Bottom-Mid-radius	297,200	4.4
Bottom-Center	288,100	2.4

Transverse Specimens -- 1850°F Austenitize, 950°F Triple Temper

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Surface	295,500	7.6
Top-Mid-radius	307,400	8.2
Top-Center	296,400	7.8
Bottom-Surface	297,000	5.9
Bottom-Mid-radius	291,000	4.0
Bottom-Center	293,200	4.4

Transverse Specimens -- 1850°F Austenitize, 975°F Triple Temper

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Surface	288,150	7.5
Top-Mid-radius	300,500	5.1
Top-Center	288,300	3.6
Bottom-Surface	285,400	5.9
Bottom-Mid-radius	290,000	11.1
Bottom-Center	285,800	4.4

Transverse Specimens -- 1850°F Austenitize, 1000°F Triple Temper

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Surface	281,500	17.4
Top-Mid-radius	289,400	5.1
Top-Center	276,000	3.1
Bottom-Surface	269,200	2.4
Bottom-Mid-radius	293,200	14.9
Bottom-Center	280,400	5.9

Longitudinal Specimens -- 1850°F Austenitize, 925°F Triple Temper

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Surface	311,250	16.3
Top-Mid-radius	314,300	5.9
Top-Center	304,500	4.0
Bottom-Surface	300,000	6.6
Bottom-Mid-radius	307,500	7.0
Bottom-Center	293,500	5.1

Acceptance test results for the vacuum induction melt-vacuum arc remelt billet of H-11 steel were as follows:

Sonic Test: Satisfactory

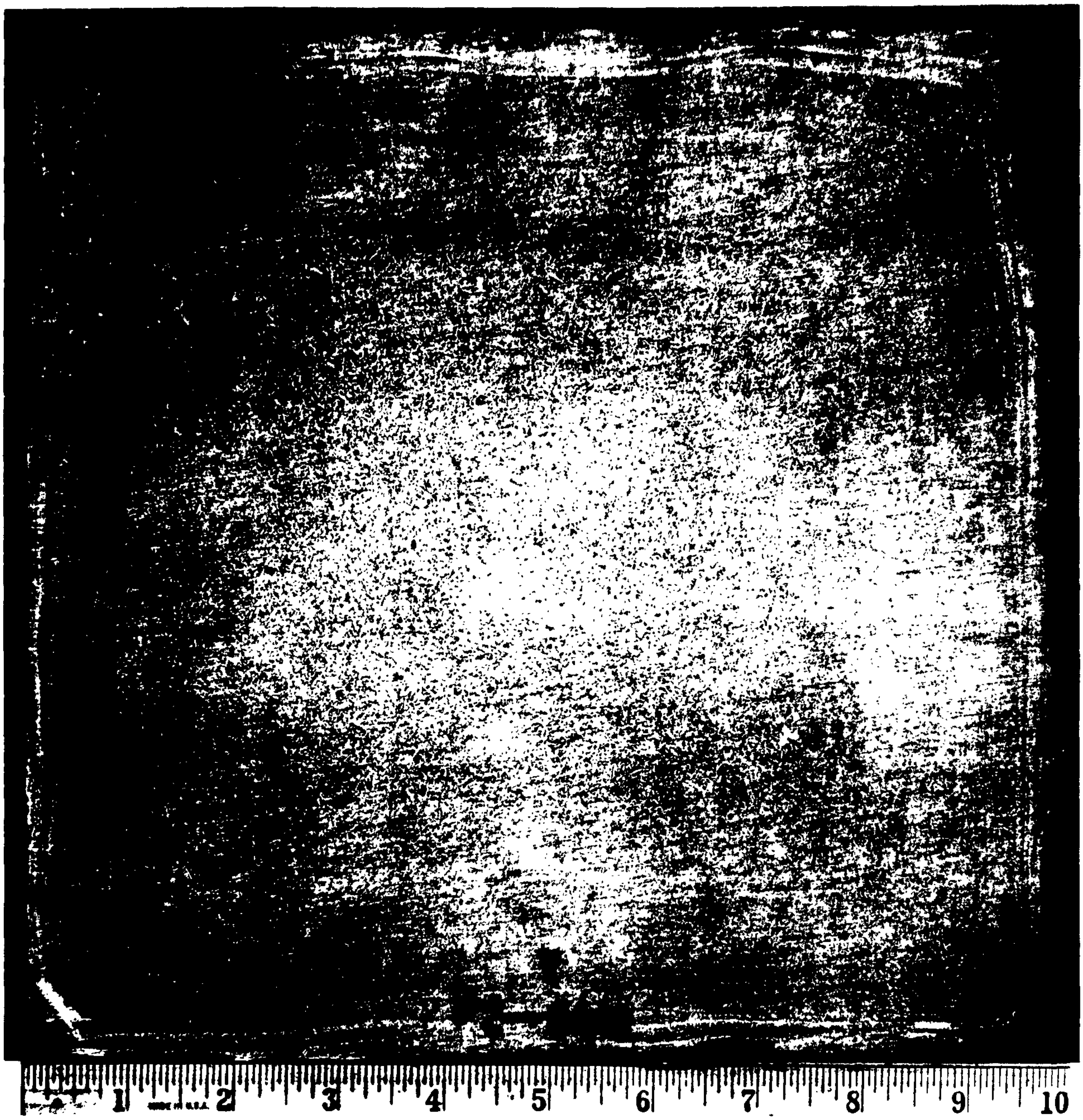
Macroetch: Transverse Section from Top of Ingot -- Figure 14
Transverse Section from Bottom of Ingot -- Figure 15
Longitudinal Section from Top of Ingot and Bottom of Ingot -- Figure 16

Magnetic Particle Inspection: (Forged stepdown bars processed per AMS-2300A)
Frequency-Severity Rating at --
Top .00/.00
Bottom .00/.00

Microstructure: See Figure 17

Microcleanliness: (ASTM E45-51, Method "A")
Surface, mid-radius, and center positions in cross section at top and bottom of billet exhibited predominantly oxide-type inclusions. Thin series = 0.5 to 1.0. Heavy series = 0.5.

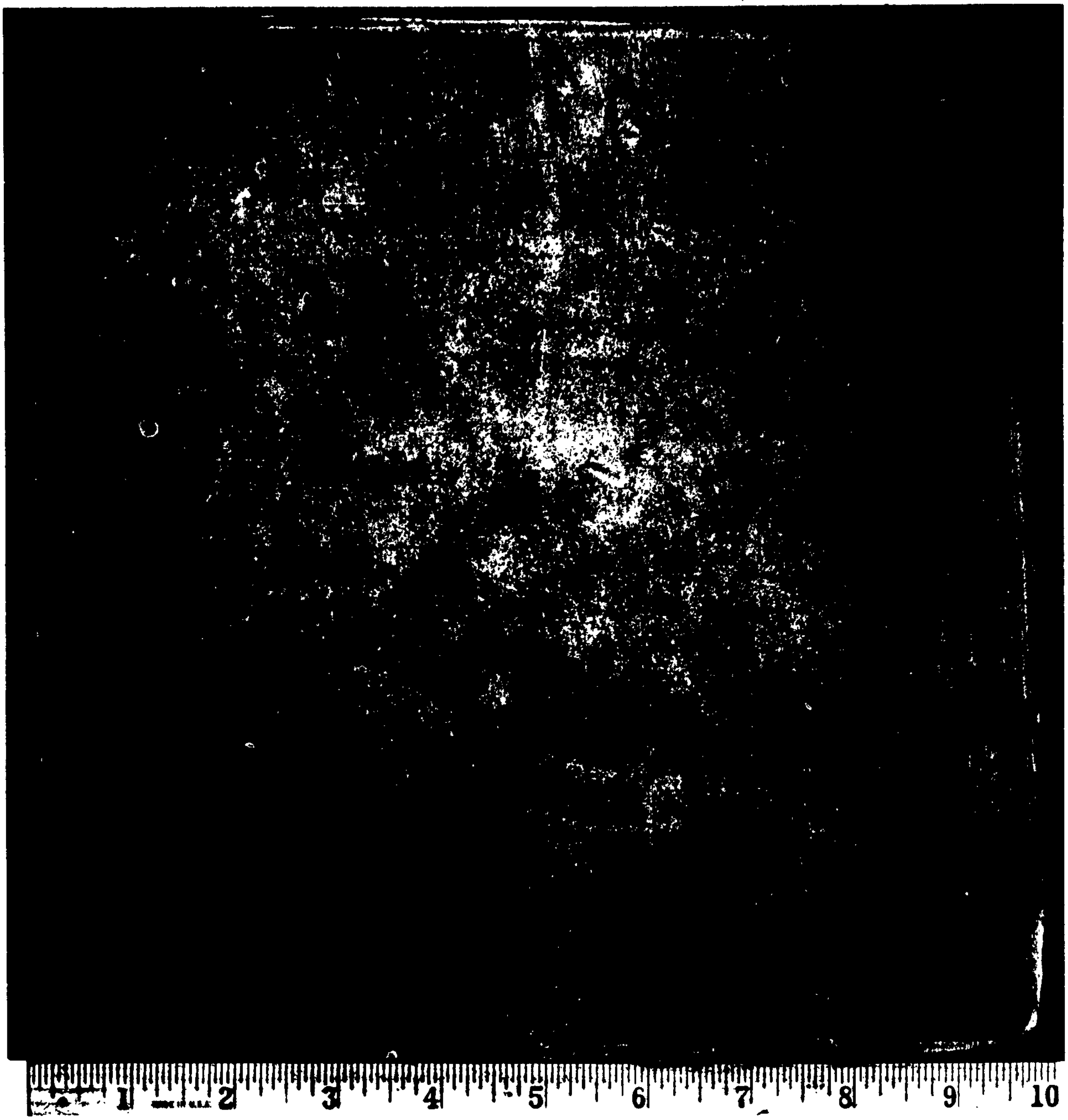
Grain Size: (Mid-radius position)
Top ---- Range 6-8, Predominant 7
Bottom - Range 6-8, Predominant 7



20037

FIGURE 14

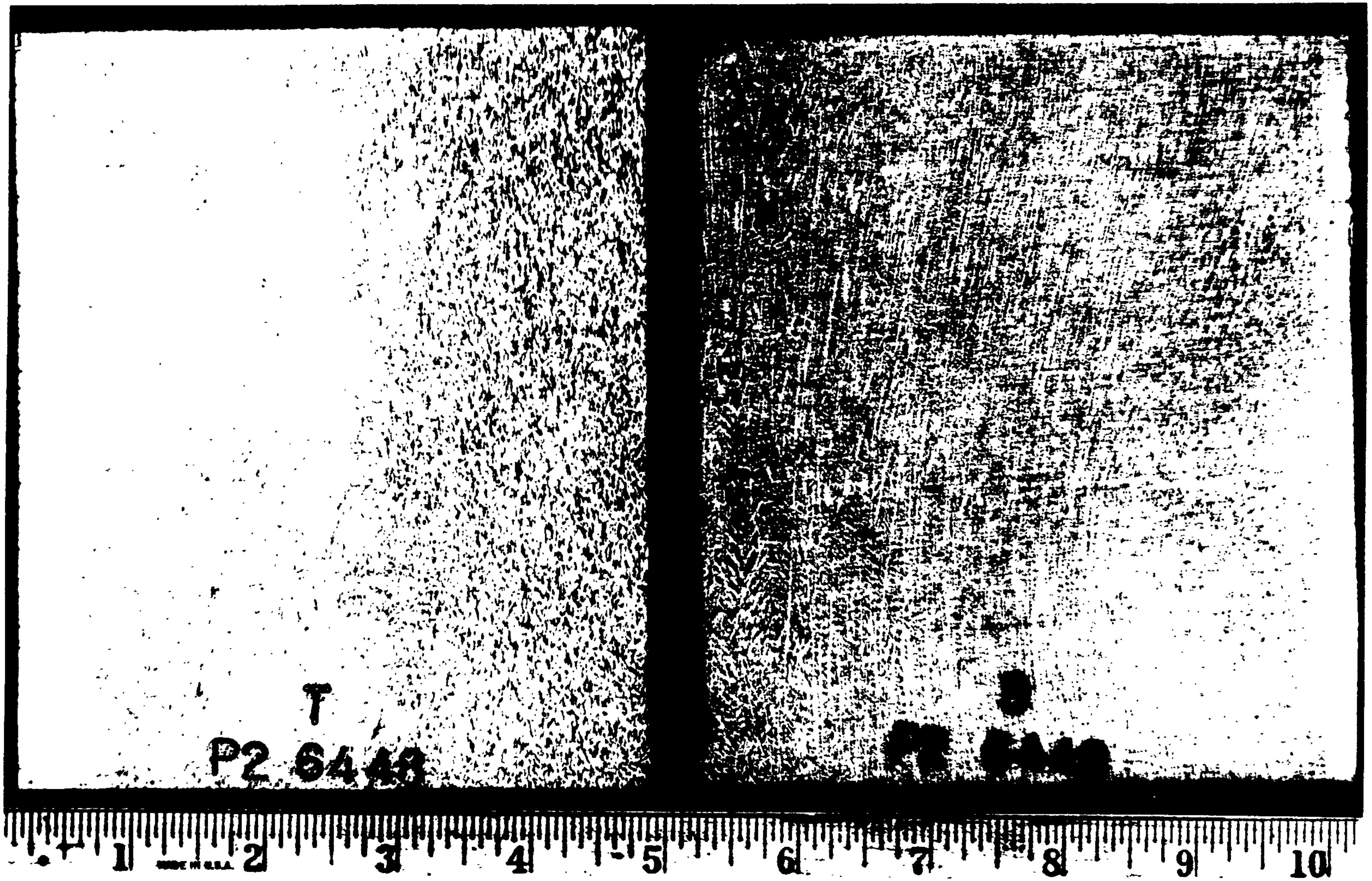
TRANSVERSE MACROETCH OF BILLET TOP --
VACUUM INDUCTION MELT-VACUUM ARC REMELT HEAT NO. W-24403-1



20038

FIGURE 15

TRANSVERSE MACROETCH OF BILLET BOTTOM --
VACUUM INDUCTION MELT-VACUUM ARC REMELT HEAT NO. W-24403-1



20036

Top

Bottom

FIGURE 16

LONGITUDINAL MACROETCH AT BILLET TOP AND BOTTOM --
VACUUM INDUCTION MELT-VACUUM ARC REMELT HEAT NO. W-24403-1

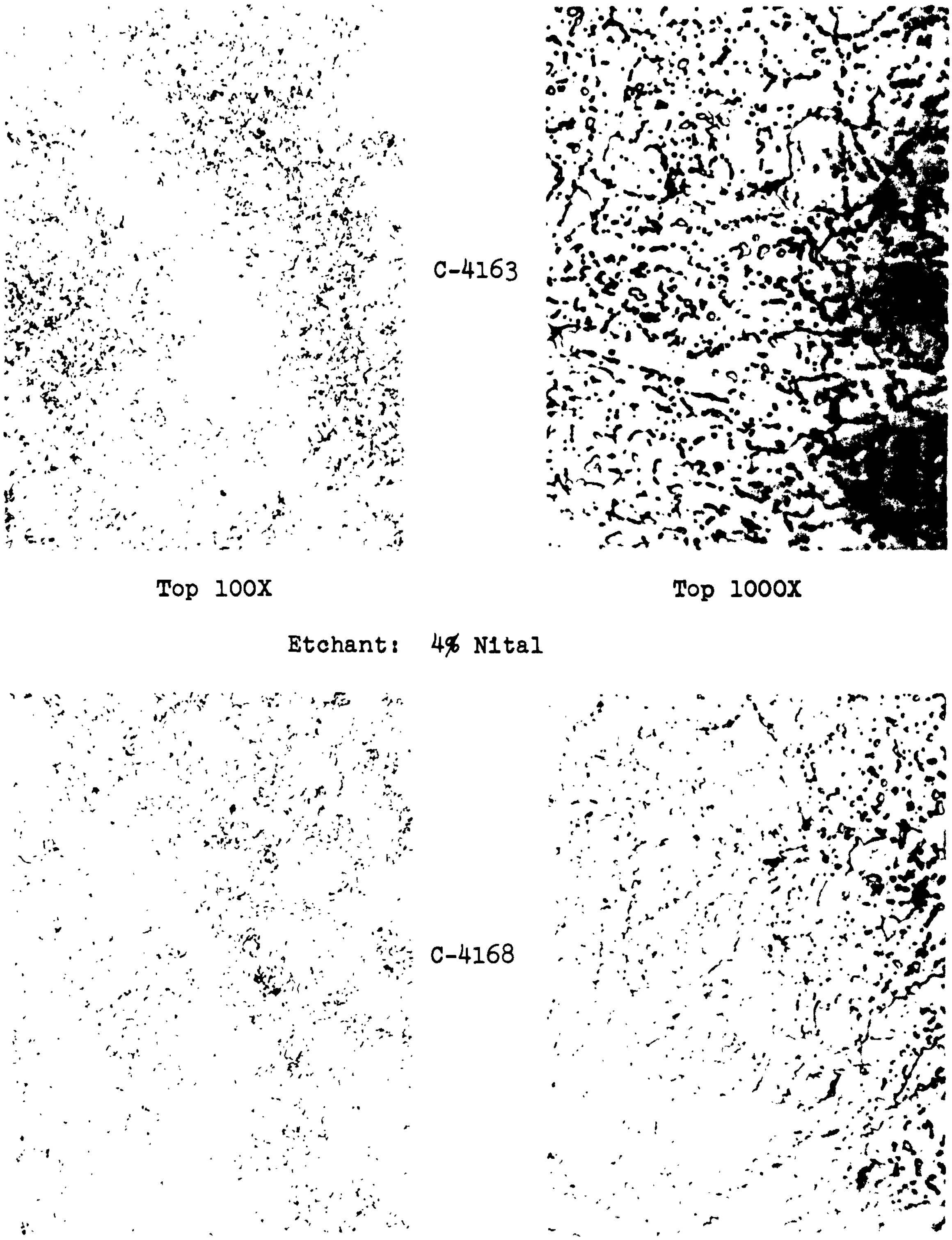


FIGURE 17

MID-RADIUS MICROSTRUCTURE AT BILLET TOP AND BOTTOM -- VACUUM INDUCTION MELT-VACUUM ARC REMELT HEAT NO. W-24403-1

Chemistry:

Location	C	Mn	P	S	Si	Ni	Cr	Mo	Cu	V
Top-Surface	.39	.18	.005	.005	.75	.20	5.15	1.29	.02	.46
Top-Mid-radius	.40	.17	.004	.005	.77	.21	5.12	1.29	.02	.45
Top-Center	.405	.18	.005	.005	.75	.20	5.10	1.26	.02	.45
Bottom-Surface	.395	.18	.005	.005	.75	.20	5.12	1.28	.02	.47
Bottom-Mid-radius	.41	.15	.004	.005	.75	.20	5.15	1.28	.02	.46
Bottom-Center	.40	.18	.005	.005	.75	.20	5.15	1.28	.02	.46
Average (Ladish Co.)	.40	.18	.005	.005	.75	.20	5.12	1.28	.02	.46
Average (Mill)	.42	.20	.005	.004	.81		5.04	1.31		.47

Tensile Tests: (0.505-inch specimen, 7/8-inch thread)

Transverse Specimens -- 1850°F Austenitize, 900°F Triple Temper

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Surface	278,800	4.4
Top-Mid-radius	281,300	7.0
Top-Center	290,000	6.2
Bottom-Surface	291,500	10.4
Bottom-Mid-radius	288,500	8.9
Bottom-Center	282,500	5.0

Transverse Specimens -- 1850°F Austenitize, 925°F Triple Temper

Top-Surface	288,750	10.0
Top-Mid-radius	283,750	8.9
Top-Center	290,000	9.6
Bottom-Surface	285,000	9.2
Bottom-Mid-radius	291,250	9.7
Bottom-Center	284,300	10.8

Transverse Specimens -- 1850°F Austenitize, 950°F Triple Temper

Top-Surface	302,500	18.4
Top-Mid-radius	287,500	11.5
Top-Center	301,250	7.7
Bottom-Surface	291,250	14.8
Bottom-Mid-radius	295,000	15.6
Bottom-Center	289,300	15.3

Transverse Specimens -- 1850°F Austenitize, 975°F Triple Temper

Top-Surface	291,000	22.7
Top-Mid-radius	294,250	14.8
Top-Center	286,500	14.8
Bottom-Surface	288,000	21.3
Bottom-Mid-radius	285,750	22.3
Bottom-Center	293,250	17.7

Transverse Specimens -- 1850°F Austenitize, 1000°F Triple Temper

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Surface	282,400	25.6
Top-Mid-radius	286,750	25.8
Top-Center	277,000	14.5
Bottom-Surface	282,000	33.1
Bottom-Mid-radius	284,000	24.1
Bottom-Center	284,000	23.7

Longitudinal Specimens -- 1850°F Austenitize, 925°F Triple Temper

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Surface	305,000	20.6
Top-Mid-radius	301,250	6.6
Top-Center	300,000	5.4
Bottom-Surface	296,500	19.2
Bottom-Mid-radius	305,000	12.2
Bottom-Center	306,250	8.5

Mill-reported values for ultimate strength and per cent reduction in area on the basis of mid-radius transverse test specimens given a 975°F triple temper were as follows:

Air Melt-Vacuum Arc Remelt Material

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Mid-radius	306,000	4
	305,000	7
	304,000	8
	302,000	9
Bottom-Mid-radius	301,000	10
	303,000	12
	303,000	10
	304,000	9

Air Melt-Vacuum Degas-Vacuum Arc Remelt Material

Location	Ultimate Strength (psi)	Reduction in Area (per cent)
Top-Mid-radius	304,000	6
	301,000	11
	306,000	8
	304,000	7
Bottom-Mid-radius	302,000	7
	304,000	9
	304,000	8
	305,000	9

Air Melt-Double Vacuum Arc Remelt Material

Location	Ultimate Strength (Psi)	Reduction in Area (per cent)
Top-Mid-radius	305,000	6
	304,000	9
	306,000	7
	305,000	6
Bottom-Mid-radius	303,000	5
	306,000	10
	304,000	8
	305,000	7

Vacuum Induction Melt-Vacuum Arc Remelt Material

Location	Ultimate Strength (Psi)	Reduction in Area (per cent)
Top-Mid-radius	314,000	13
	316,000	13
	308,500	16
	312,000	15
Bottom-Mid-radius	312,500	19
	320,000	24
	314,500	22
	312,000	20

Comparison of acceptance test results for each process variation resulted in the following preliminary observations:

1. The vacuum induction melted-vacuum arc remelted material appeared to provide substantially higher ductility in both longitudinal and transverse directions than the other three melting process variations.
2. The air melted-double vacuum arc remelted material appeared to possess the lowest ductility.
3. Based upon both longitudinal and transverse ductility, the apparent order of preference was (a) vacuum induction melt-VAR, (b) air melt-vacuum degas-VAR, (c) air melt-VAR, and (d) air melt-double VAR.
4. The air melt-VAR and air melt-vacuum degas-VAR materials appeared to demonstrate a more erratic strength-ductility

relationship than the vacuum induction melt-VAR and air melt-double VAR materials.

5. The vacuum induction melt-VAR billet evidenced the most uniform macroetch appearance in full transverse cross section as seen in Figures 14 and 15. The air melt-double VAR billet displayed the least uniform transverse macroetch appearance, particularly at the bottom location shown in Figure 11. Although Figure 11 established that the bottom of the double remelt billet did not meet the macroetch acceptance requirement of a three-or-better reading on the Ladish Co. Freckle Rating Chart, a decision against rejecting part of the bottom portion of the billet was made for two reasons.

   The minimal length of the double consutroded billet (shortest of the four billets received) did not provide any allowance for rejecting end material without reducing the number of billet sections and test specimens which had been preplanned for the testing program. In addition, it was felt that existence of some material with greater than the desired degree of chemical segregation, as indicated by failure to conform to the macroetch requirement, would serve to extend slightly the range of quality levels under investigation. Therefore, it was decided that all of the double VAR material received should be tested.

6. A 950°F tempering temperature appeared to be optimum for all

relationship than the vacuum induction melt-VAR and air melt-double VAR materials.

5. The vacuum induction melt-VAR billet evidenced the most uniform macroetch appearance in full transverse cross section as seen in Figures 14 and 15. The air melt-double VAR billet displayed the least uniform transverse macroetch appearance, particularly at the bottom location shown in Figure 11. Although Figure 11 established that the bottom of the double remelt billet did not meet the macroetch acceptance requirement of a three-or-better reading on the Ladish Co. Freckle Rating Chart, a decision against rejecting part of the bottom portion of the billet was made for two reasons.

   The minimal length of the double consutroded billet (shortest of the four billets received) did not provide any allowance for rejecting end material without reducing the number of billet sections and test specimens which had been preplanned for the testing program. In addition, it was felt that existence of some material with greater than the desired degree of chemical segregation, as indicated by failure to conform to the macroetch requirement, would serve to extend slightly the range of quality levels under investigation. Therefore, it was decided that all of the double VAR material received should be tested.

6. A 950°F tempering temperature appeared to be optimum for all

four remelt process variations from the standpoint of developing maximum ductility at the 300 Ksi strength level. Mill-reported strength values (mid-radius specimens given a 975°F temper) exceeded comparable Ladish Co. acceptance test results which were predominantly below 300 Ksi. The 950°F temper increased the number of values at a 300 Ksi strength level.

7. Mill test results confirmed the Contractor's findings of superior ductility in the vacuum induction melt-VAR processed material.

8. The carbon content of air melt-VAR, air melt-degas-VAR, and air melt-double VAR heats of material (all produced from the same master air melt heat) tended toward the low side of the specified range of carbon contents. The carbon content of the vacuum induction melt-VAR material was on the high side of the specified range, but manganese and vanadium were on the low side. Nickel content of the vacuum induction melt-VAR heat was higher than that in the other three varieties of material.

The photomicrographs in Figures 5, 9, 13, and 17 show the as-received microstructure of each of the four billets at top and bottom extremities under magnifications of 100 and 1000. All specimens are from mid-radius locations with respect to billet cross section.

The thermal processing of all four billets at the mill subsequent to press forging consisted of a spheroidize anneal treatment

(slow cooling at a rate of 25°F per hour). Consequently, observed differences in microstructure may be attributed to melt process variations, particularly since the air melt-VAR, air melt-degas-VAR and air melt-double VAR billets all originated from the same master air melt heat of electric furnace-produced material.

At 100X, noticeable light and dark etching bands or areas may be observed at both the top and bottom locations in the air melt-VAR billet, Figure 5; at the bottom location in the air melt-degas-VAR billet, Figure 9; and to a lesser degree at the top location in the double VAR billet, Figure 13. Furthermore, at 100X the bottom location in Figure 5 and the top and bottom locations in Figure 13 evidence of considerable grain boundary precipitation may be observed. This condition appears to be most continuous at the bottom location in the double VAR billet as shown in Figure 13.

At 1000X, considerable evidence of well-spheroidized particles may be observed in all figures. However, dispersion appears to be least uniform in the air melt-double VAR billet. Here, spheroidization appears the least complete, since numerous grain boundaries exhibit heavy and nearly continuous precipitate accumulations. The air melt-VAR billet is judged to show the most uniform dispersion.

E. Material Processing

Subsequent to the evaluation of acceptance test results, each of the four vacuum arc remelt billets was sectioned and subsectioned as shown in Figure 18 in order to provide 928 tensile test specimen blanks per billet.

The 16 major billet sections were removed progressively from the top and bottom billet extremities and were identified with an alpha code which was preserved throughout subsequent processing and tensile testing. Sectioning of billets in a manner which located any excess material at the center of the billet length, rather than at the top or bottom end, provided for an evaluation of data on the most comparable basis practicable. To further insure representative sampling of the billet material, the specimen location layout was rotated 90 degrees for each successive billet section from top to bottom of the billet, thereby avoiding specimen repetition on the same side of successive sections. Distribution of the 58 blanks removed from each of the 16 major sections of each billet with respect to specimen type, direction, location, and code number is shown in Table II.

Six hundred and forty smooth and 288 notched tensile specimens were prepared from each billet. Both smooth and notched specimens were of the threaded, 1/2-inch diameter variety. The stress concentration factor for the notched specimens was $K_T = 5$. Additional specimen details are shown in Figure 19.

Test blanks were center-drilled and rough-machined to 0.100-inch

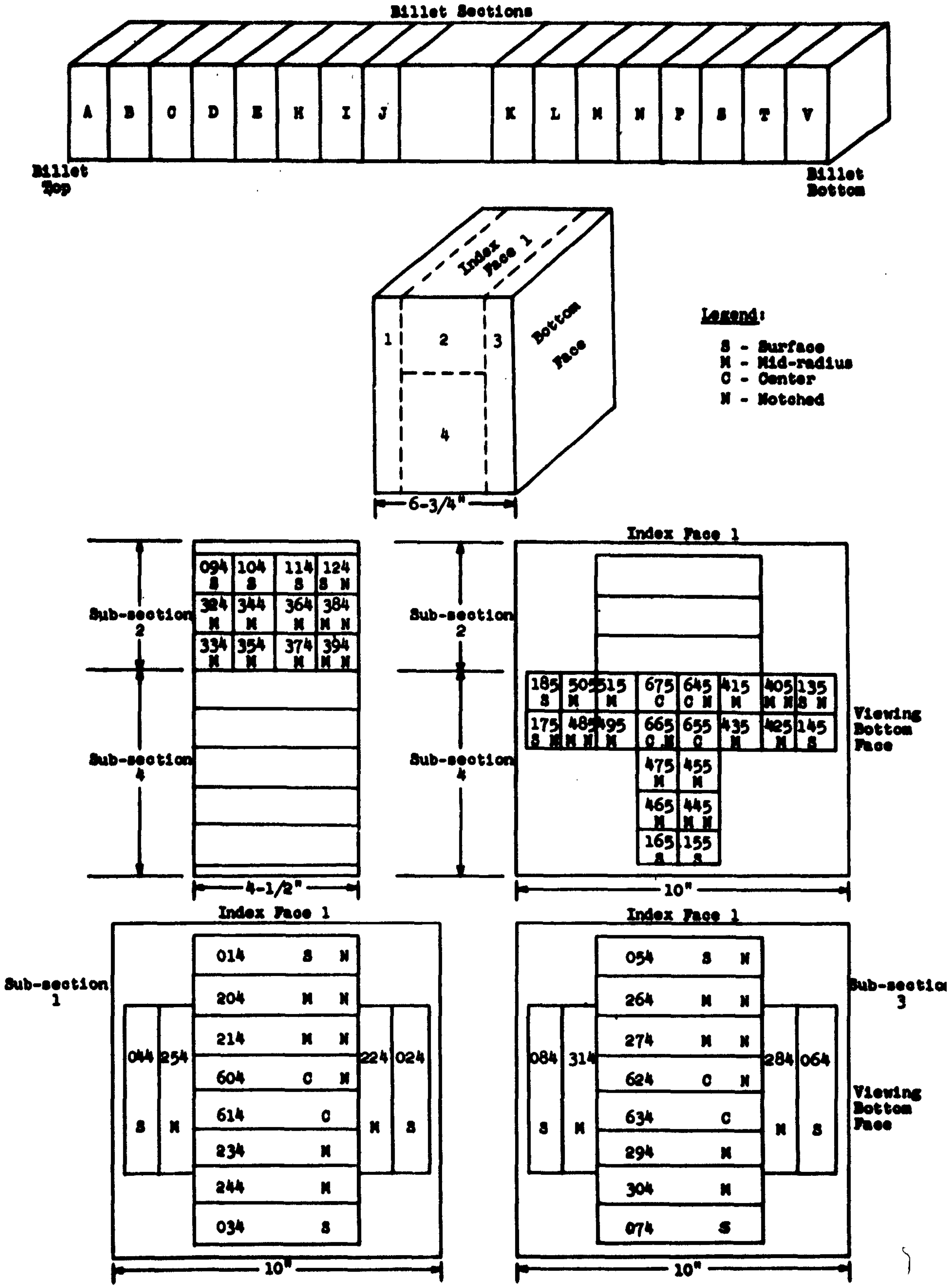


FIGURE 18

BILLET SECTIONING DIAGRAM

TABLE II

TENSILE SPECIMEN IDENTITY AND DISTRIBUTION IN EACH MAJOR BILLET SECTION

SECTION IDENTITY	SMOOTH SPECIMENS						NOTCHED SPECIMENS					
	LONGITUDINAL			TRANSVERSE			LONGITUDINAL			TRANSVERSE		
	Center	Mid-radius	Surface	Center	Mid-radius	Surface	Center	Mid-radius	Surface	Center	Mid-radius	Surface
Sub-Section 1 (12 Specimens)				614	224 234 244 254	024 034 044				604	204 214	014
Sub-Section 2 (12 Specimens)					324 334 344 354 364 374	094 104 114					384 394	124
Sub-Section 3 (12 Specimens)				634	284 294 304 314	064 074 084				624	264 274	054
Sub-Section 4 (22 Specimens)	655 675	415 425 435 455 465 475 495 505 515	145 155 165 185				645 665	405 445 485	135 175			
58	2	9	4	2	14	9	2	3	2	2	6	3
TOTALS	15			25			7			11		
	40						18					

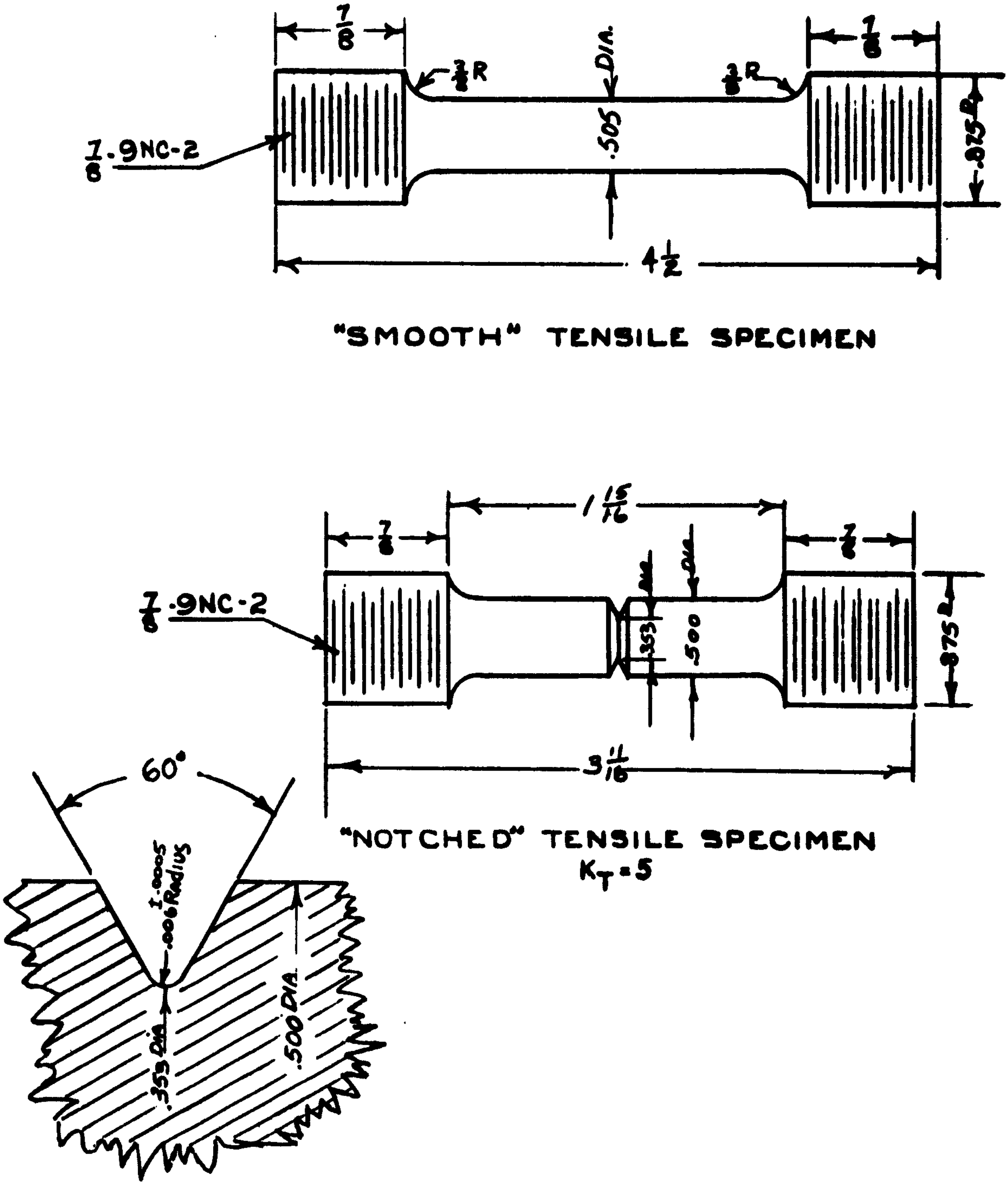


FIGURE 19

SMOOTH AND NOTCHED TENSILE SPECIMEN DESIGN
FOR H-11 STEEL TESTED BY CONTRACTOR

oversize prior to heat treatment. For heat treat control purposes, one-inch square hardness blocks were prepared from billet material at locations adjacent to the end of surface and mid-radius notched specimens. The heat treatment of the 3712 rough-machined test blanks and associated hardness blocks consisted of austenitizing, forced-air quenching to harden, and triple tempering. Since it was deemed desirable to limit the influence of unavoidable variations in treatment conditions upon the response of the specimen blanks to the austenitize-and-harden cycle, the test blanks were regrouped for this operation. The 928 rough-machined test blanks and 116 hardness blocks from each of the four billets were arranged into 58 separate groups consisting of one tensile blank from each of the 16 billet sections and two hardness test blocks representing material from the top and bottom of the billet. The effect of this arrangement was to minimize the influence of any deviation in heat treat response which might result from a slight variation in conditions from charge to charge.

In addition to the normal electric furnace temperature control system, an auxiliary temperature recorder and separate thermocouple were used with each charge to ensure exactness of temperature and time at temperature.

The austenitize-and-harden treatment given the above 58 groups of specimens from each billet was identical for each melt practice, specifically:

1. Pre-heat at 1400°F for one hour (at temperature).
2. Austenitize at 1850°F for one hour (at temperature).
3. Forced-air quench to less than 150°F.

The cooling devices used for the forced-air quench portion of the treatment consisted of a motorized wire mesh drum which rotated at 10 revolutions per minute and a centrifugal fan with a capacity of approximately 700 cubic feet per minute. The output of the fan was directed through the mesh toward the center of the drum to ensure rapid, uniform cooling of specimens as they were tumbled.

After the above treatment had been applied to specimens and hardness blocks, all 464 hardness blocks were processed and tested to determine the effectiveness of the hardening operation.

The 3712 specimens and 464 hardness blocks were subsequently processed through the tempering operations in groups of 16 specimens and two hardness blocks from each billet. First, second, and third temper operations were each performed at 950°F for two hours (at temperature) followed by still-air cooling to room temperature. Hardness blocks were reprocessed and tested after the second and third temper operations.

Critical sections of all test specimens were ground to final dimensions. All smooth contour grinding was done with a Norton Model Type C, six by 18-inch cylindrical grinder operating with a work head speed of 530 RPM, and a Norton Grade 57A 60 L5VBE wheel at 6500 surface feet per minute. Wheel form was maintained by crushing as necessary. Texas Oil Company Soluble CX, a water-soluble oil, was employed as coolant.

The gauge length of the smooth tensile specimens was polished

with No. 320 abrasive cloth strips. Conformance to dimensional specifications was verified by use of a Jones & Lamson Model BC 14 optical comparator at 62.5 magnification.

Residual stresses resulting from grinding and polishing were subsequently relieved by a 3-hour thermal treatment at 650°F. Specimens were then air cooled to room temperature.

All tensile specimens were tested on Baldwin-Lima-Hamilton hydraulically-loaded tensile machines of 120,000 and 300,000-pound capacities, with the lesser capacity machine used to test the notched tensile specimens. Loading rate used for both smooth and notched specimens was 75,000 psi per minute to yield, with no increase in load thereafter to failure. Testing rates and methods were within the limits specified for Method 211 in Federal Test Method Standard No. 151.

All fractured specimens were identified and stored. Data from each test was punched into an IBM card and processed for statistical analysis. Machine tabulations of arrayed data are presented in Appendices I through IV.

III. DATA PROCESSING

All tensile test data was thoroughly screened for accuracy and completeness of property values as developed. A few tests, in which specimens failed in the threads, or in which deviations from established processing or testing procedures occurred, were voided in their entirety. In some instances only a portion of the data to be derived from a single specimen could be reported. For example, extensometer difficulties or slippage occasionally resulted in the necessity for voiding a yield strength value. Similarly, inability to recover all specimen fragments after fracture made it impossible to report elongation and/or reduction in area values in other instances. The amount of data which could not be reported because of all such causes comprised a very small percentage of the total data collected. Of the 2560 smooth tensile tests performed, only 14 ultimate strength values and 15 reduction in area values were lost. With notched specimens, the percentage was even less significant. Ultimate strength values were reported for all but two of the 1152 notched specimens tested. The notched/smooth strength ratio could not be computed for 10 specimens, however, because of the lack of associated smooth ultimate strength values.

All acceptable data was translated onto punched IBM cards. Test results and pertinent identifying information which would facilitate statistical evaluation of the effects of (a) melt process variation, (b) specimen direction, (c) specimen type, (d) specimen location with respect to billet length, and (e) specimen

location with respect to billet cross section, were incorporated.

Each data card was processed through a verifier by a second operator to ensure the accuracy of data to be analyzed. A tabulated runoff of each test result was printed by an IBM 407 accounting machine. The runoff was given a critical review to provide further assurance of the accuracy of data to be analyzed statistically.

At this point, ultimate strength values from adjacent notched and smooth specimens were reproduced into a new deck of IBM cards which was subsequently processed by an IBM 1401 computer to provide the notched/smooth ratio. This value was then reproduced on the IBM card originally prepared for each notched specimen.

The 928 cards for each of the four melt processes then were resorted by specimen type (smooth and notched), direction (transverse and longitudinal), and location (surface, mid-radius, and center) in each of the 16 billet sections and the information was listed by the IBM 407 accounting machine for subsequent reproduction as Appendices I through IV, provided at the end of this report. Each of these four appendices, covering all test data developed for one of the four remelt process variations studied, is subdivided into four sections containing data from the appropriate heat for (1) smooth transverse, (2) smooth longitudinal, (3) notched transverse, and (4) notched longitudinal specimens, respectively.

All data was re-run on the IBM 407 to provide sub-totals of

property values by individual billet section and to total these property values across each entire billet. Totals were used to calculate arithmetic mean ($\bar{X}$) and range (R) values for each billet section. Values were subsequently plotted in the form of control charts, provided in Appendix VI, to illustrate the variation of mechanical property data from top to bottom of each billet. Upper and lower control values given on each chart in Appendix VI represent the three sigma limits of the average mean ($\bar{\bar{X}}$) or average range ($\bar{R}$) of specific property variables (yield and ultimate strength, elongation, reduction in area, notched strength and notched/smooth ratio). The control charts indicate the relative degree of control provided by each melting practice for each property variable.

Next, IBM test data cards for each mill practice were re-sorted by specimen type (smooth and notched), direction (transverse and longitudinal), and location (surface, mid-radius, and center) in each billet without regard for individual billet section. This arrangement was accomplished to permit a distribution analysis and the calculation of statistical criteria for subsequent evaluation. It provided the following breakdown:

- SMOOTH (640)
  - LONGITUDINAL (240)
    - SURFACE (64)
    - MID-RADIUS (144)
    - CENTER (32)
  - TRANSVERSE (400)
    - SURFACE (144)
    - MID-RADIUS (224)
    - CENTER (32)

NOTCHED (288)

- LONGITUDINAL (112)
  - SURFACE (32)
  - MID-RADIUS (48)
  - CENTER (32)
- TRANSVERSE (176)
  - SURFACE (48)
  - MID-RADIUS (96)
  - CENTER (32)

The original IBM data cards were next reproduced to establish separate decks for each of the following tensile properties: (1) smooth specimen ultimate strength, (2) smooth specimen per cent reduction in area, (3) notched specimen ultimate strength, and (4) notched/smooth strength ratio. Card format employed was that required for processing data on an IBM 1620 computer.

The 1620 computer program was obtained from IBM's General Program Library and is entitled DISTAT (<u>Dis</u>tribution of <u>Stat</u>istics) 6.0.012.[1] The decks were prepared so as to permit initial processing on the basis of the smallest groups first. Then by combining, groups were reprocessed to evaluate broader conditions. In this manner a total of 36 groups per heat, or a total of 144 groups in all, were statistically analyzed.

The 36 groups from each billet actually represented nine combinations of material variables for both smooth and notched specimens (longitudinal surface, mid-radius, and center, individually and combined (four groups); transverse surface, mid-radius, and center, also individually and combined (four more groups); and combined transverse and longitudinal (ninth group)). Since two

1 Developed by H. E. Anderson, Sandia Corporation, Albuquerque, N.M.

test variables were also represented (ultimate strength and per cent reduction in area for smooth specimens, and ultimate strength and notched/smooth ratio for notched specimens), the arrangement comprised 18 groups of data for each type of specimen (smooth and notched), or a total of 36 groups of data per heat.

In addition to statistical criteria determined by the IBM 1620 computer for each group of data, including frequency, arithmetic mean, standard deviation, variance maximum and minimum values, range, and standard deviation of the mean, a histogram plot of the data for each of the four test variables was also provided. The computer-developed histogram for each of the 144 groups of data provided cell mid-point values (rounded to three places), number of observations falling within each cell, and a graph of the distribution truncated at a frequency of 55 values. This limitation was a function of the maximum stop setting of the console typewriter on which the data was printed. The computer program determined limits and cell size for each histogram on the basis of sample size and range of data. The histogram for each of the 36 combinations of material and test variables evaluated for each vacuum arc remelt process variation is contained in Appendix V.

IV. DATA EVALUATION

In the effort directed toward evaluation of the effects on mechanical properties of high-strength H-11 steels introduced by known variables such as melting practice, location from top to bottom within the billet, position of test specimens from surface to center of the billet, specimen direction with respect to the primary direction of rolling or working, and type of tensile specimen with respect to notch sensitivity, the mass of data generated from 3712 tests was analyzed by two basic statistical methods, namely, frequency distribution and control chart methods.

The frequency distribution method was chosen because it is a means of reliably translating large and small samples of comparatively unintelligible data into meaningful, understandable terms comparable with those of other samples representing similar or dissimilar conditions. Thus, it provided a common denominator for making direct comparisons between the 144 groups of data.

The control chart method provided a means of reliably comparing the arithmetic mean and range of tensile properties in each section of each billet on the basis of repetitive identical samples, thereby affording a continual check on process reproducibility of a single variable over the entire billet length.

Tensile test data subjected to the frequency distribution method of analysis (i.e., ultimate strength and per cent reduc-

tion in area of smooth specimens, and ultimate strength and notched/smooth strength ratio of notched specimens) was used to produce the 144 histograms contained in Appendix V. These are summarized in Tables III through VI wherein sample size (N), arithmetic mean ($\bar{X}$), and standard deviation (σ) are tabulated for each property, group of data, and remelt process variation.

Tensile test data subjected to the control chart method of analysis (i.e., smooth specimen values for yield and ultimate strength, per cent elongation and reduction in area, and notched specimen values for ultimate strength and notched/smooth strength ratio) yielded the 48 charts contained in Appendix VI. An individual chart, containing both mean and range values, is provided for each tensile property and specimen direction. Thus, twelve charts are provided for each remelt process variation to illustrate the degree of variation of each tensile property successively along the length of the billet. Upper and lower control limits for overall mean ($\bar{\bar{X}}$) values and mean range ($\bar{R}$) values are provided to indicate which billet sections are out of control with respect to a three-sigma deviation from the mean.

Data graphically represented in Appendix VI is summarized in Tables VII through X wherein mean and range values for all tensile test data is tabulated by billet section and by specimen type and direction.

For comparative purposes the $\bar{X}$ and σ values tabulated in Tables III through VI were plotted in Figures 20 through 31, in order

TABLE III

STATISTICAL SUMMARY OF SMOOTH AND NOTCHED TENSILE TEST DATA FOR AIR MELT-VACUUM ARC REMELT HEAT W-24341-1 COMPUTED BY SPECIMEN DIRECTION AND LOCATION

SPECIMEN TYPE		SMOOTH						NOTCHED					
DIRECTION AND LOCATION		ULTIMATE STRENGTH (KSI)			REDUCTION IN AREA (PER CENT)			ULTIMATE STRENGTH (KSI)			NOTCHED/SMOOTH RATIO		
		N	$\overline{X}$	σ	N	$\overline{X}$	σ	N	$\overline{X}$	σ	N	$\overline{X}$	σ
Longitudinal	Center	32	295.9	5.3	32	7.9	2.4	31	213.0	21.2	32	.74	.11
	Mid-radius	142	293.2	6.6	142	8.3	3.0	47	249.1	26.5	47	.86	.09
	Surface	63	299.7	4.8	64	17.5	5.3	32	261.6	19.6	32	.86	.09
Longitudinal (Center, Mid-radius, Surface Combined)		237	295.3	6.6	238	10.7	5.5	110	242.6	30.0	111	.82	.11
Transverse	Center	30	283.7	4.4	30	4.0	1.6	32	185.0	23.2	30	.63	.09
	Mid-radius	220	293.3	7.4	220	5.3	2.4	96	202.8	38.8	94	.69	.12
	Surface	144	292.2	6.2	144	9.1	3.7	48	236.1	31.5	48	.83	.10
Transverse (Center, Mid-radius, Surface Combined)		394	292.2	7.2	394	6.6	3.5	176	208.6	38.8	172	.72	.13
Process Variation		631	293.3	7.2	632	8.1	4.8	286	221.7	39.3	283	.76	.13

TABLE IV

STATISTICAL SUMMARY OF SMOOTH AND NOTCHED TENSILE TEST DATA FOR
AIR MELT-DEGAS-VACUUM ARC REMELT HEAT W-24342-V1
COMPUTED BY SPECIMEN DIRECTION AND LOCATION

SPECIMEN TYPE		SMOOTH						NOTCHED					
DIRECTION AND LOCATION		ULTIMATE STRENGTH (KSI)			REDUCTION IN AREA (PER CENT)			ULTIMATE STRENGTH (KSI)			NOTCHED/SMOOTH RATIO		
		N	$\overline{X}$	σ	N	$\overline{X}$	σ	N	$\overline{X}$	σ	N	$\overline{X}$	σ
Longitudinal	Center	30	299.7	3.7	31	6.7	2.3	32	218.7	31.9	29	.71	.07
	Mid-radius	144	302.6	3.7	144	7.6	3.6	48	251.8	26.6	47	.82	.09
	Surface	64	293.7	8.1	64	14.0	4.7	31	258.7	26.8	31	.88	.07
Longitudinal (Center, Mid-radius, Surface Combined)		238	299.8	6.5	239	9.2	4.8	112	244.1	32.4	108	.81	.10
Transverse	Center	32	292.6	6.6	32	4.3	2.4	32	176.7	26.6	32	.63	.08
	Mid-radius	223	297.0	8.9	222	5.8	2.9	96	201.2	33.9	96	.69	.13
	Surface	144	290.4	6.6	144	8.1	3.3	48	241.7	30.4	48	.82	.11
Transverse (Center, Mid-radius, Surface Combined)		399	294.3	8.6	398	6.5	3.2	176	207.8	38.9	176	.71	.13
Process Variation		637	296.4	8.3	637	7.5	4.1	288	221.9	40.5	284	.75	.13

TABLE V

STATISTICAL SUMMARY OF SMOOTH AND NOTCHED TENSILE TEST DATA FOR AIR MELT-DOUBLE VACUUM ARC REMELT HEAT W-24341-2 COMPUTED BY SPECIMEN DIRECTION AND LOCATION

SPECIMEN TYPE		SMOOTH						NOTCHED					
DIRECTION AND LOCATION		ULTIMATE STRENGTH (KSI)			REDUCTION IN AREA (PER CENT)			ULTIMATE STRENGTH (KSI)			NOTCHED/SMOOTH RATIO		
		N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ	N	$\bar{X}$	σ
Longitudinal	Center	32	298.6	8.4	32	6.8	2.4	32	233.3	28.1	32	.78	.09
	Mid-radius	144	301.4	10.0	144	7.2	3.6	48	255.0	25.0	48	.85	.09
	Surface	64	298.8	5.3	64	9.5	5.3	32	257.0	24.0	32	.86	.09
Longitudinal (Center, Mid-radius, Surface Combined)		240	300.3	8.9	240	7.8	4.1	112	249.4	27.4	112	.83	.10
Transverse	Center	31	288.9	12.9	31	3.0	1.4	32	182.0	42.2	31	.63	.15
	Mid-radius	223	292.1	11.7	222	3.7	1.5	96	213.2	41.2	96	.73	.15
	Surface	144	290.7	14.3	143	4.7	2.4	48	235.8	25.1	48	.82	.09
Transverse (Center, Mid-radius, Surface Combined)		398	291.3	12.8	396	4.0	1.9	176	213.6	41.5	175	.74	.15
Process Variation		638	294.7	12.3	636	5.4	3.5	288	227.6	40.6	287	.77	.14

TABLE VI

STATISTICAL SUMMARY OF SMOOTH AND NOTCHED TENSILE TEST DATA FOR VACUUM INDUCTION MELT-VACUUM ARC REMELT HEAT W-24403-1 COMPUTED BY SPECIMEN DIRECTION AND LOCATION

SPECIMEN TYPE		SMOOTH						NOTCHED					
DIRECTION AND LOCATION		ULTIMATE STRENGTH (KSI)			REDUCTION IN AREA (PER CENT)			ULTIMATE STRENGTH (KSI)			NOTCHED/SMOOTH RATIO		
		N	$\overline{X}$	σ	N	$\overline{X}$	σ	N	$\overline{X}$	σ	N	$\overline{X}$	σ
Longitudinal	Center	32	288.4	3.6	32	11.0	2.1	32	241.2	21.3	32	.84	.08
	Mid-radius	144	296.1	4.3	144	12.1	3.3	48	261.8	31.6	48	.88	.10
	Surface	64	295.4	5.3	64	18.4	3.8	32	278.9	26.6	32	.94	.09
Longitudinal (Center, Mid-radius, Surface Combined)		240	294.9	5.2	240	13.6	4.4	112	260.8	30.9	112	.89	.10
Transverse	Center	32	290.3	2.2	32	9.4	3.5	32	221.8	24.5	32	.76	.09
	Mid-radius	224	294.3	3.8	224	13.0	4.0	96	233.1	30.1	96	.79	.10
	Surface	144	293.7	6.9	144	13.6	5.7	48	246.7	26.9	48	.84	.10
Transverse (Center, Mid-radius, Surface Combined)		400	293.8	5.2	400	12.9	4.7	176	234.8	29.4	176	.80	.10
Process Variation		640	294.2	5.2	640	13.2	4.6	288	244.9	32.5	288	.83	.11

TABLE VII

STATISTICAL SUMMARY OF SMOOTH AND NOTCHED TENSILE TEST DATA FOR AIR MELT-VACUUM ARC REMELT HEAT W-24341-1 COMPUTED BY BILLET SECTION

Billet Section	Statistical Value	SPECIMEN TYPE											
		SMOOTH								NOTCHED			
		LONGITUDINAL				TRANSVERSE				LONGITUD.		TRANSV.	
		F_{ty} KSI	F_{tu} KSI	% E.	% R.A.	F_{ty} KSI	F_{tu} KSI	% E.	% R.A.	F_{tu} KSI	N/S RATIO	F_{tu} KSI	N/S RATIO
A	$\bar{X}$	238.9	304.2	4.3	9.1	237.7	298.3	2.9	5.3	231.8	.76	191.7	.66
	R	16.8	17.5	6.5	19.2	20.1	31.0	5.0	9.3	108.8	.35	139.2	.42
B	$\bar{X}$	237.1	304.0	4.2	7.7	235.4	292.0	2.7	4.8	259.6	.83	198.2	.69
	R	15.5	20.0	3.0	9.5	17.1	44.5	5.5	10.7	101.8	.34	145.8	.39
C	$\bar{X}$	232.4	296.7	4.4	9.8	233.4	292.4	3.1	5.4	265.3	.89	207.2	.72
	R	19.5	12.8	6.0	5.5	19.0	36.0	7.0	14.9	51.2	.20	91.6	.37
D	$\bar{X}$	231.0	297.7	4.9	10.4	233.9	293.1	3.2	6.3	245.1	.82	195.1	.69
	R	13.1	21.2	7.0	25.2	22.6	28.2	5.5	16.2	83.9	.19	112.5	.38
E	$\bar{X}$	232.2	297.7	4.8	10.2	233.2	293.6	3.7	6.7	250.6	.84	211.2	.72
	R	13.5	17.5	5.5	19.1	19.0	27.3	6.5	16.2	48.5	.15	111.3	.35
H	$\bar{X}$	229.2	293.0	5.1	14.3	232.4	294.2	3.5	6.8	257.9	.88	208.6	.72
	R	26.7	28.3	6.5	25.3	14.1	33.6	5.0	12.6	96.7	.32	106.4	.35
I	$\bar{X}$	230.9	293.8	5.4	10.6	232.2	293.1	3.3	6.2	257.9	.88	217.5	.75
	R	15.7	15.5	5.0	17.7	17.7	27.0	5.5	12.2	117.4	.43	109.8	.47
J	$\bar{X}$	231.4	296.0	5.6	11.8	232.5	292.1	3.3	6.3	272.6	.92	224.3	.78
	R	11.3	15.0	5.0	17.0	14.2	25.3	5.5	12.3	52.8	.16	135.8	.52
K	$\bar{X}$	228.5	294.3	5.1	10.0	230.3	290.6	3.5	6.6	249.9	.84	215.4	.75
	R	16.5	15.8	4.7	14.8	19.7	28.8	5.5	8.9	70.8	.24	103.1	.36
L	$\bar{X}$	228.2	293.6	5.3	10.8	230.7	292.0	3.6	6.8	256.5	.87	220.4	.76
	R	21.4	23.3	6.5	20.6	18.0	18.2	4.7	11.4	50.4	.16	100.1	.33
M	$\bar{X}$	227.9	293.1	5.0	11.3	229.0	290.9	3.6	6.0	222.1	.76	191.6	.66
	R	13.8	13.4	4.5	14.9	20.6	22.5	6.0	14.6	109.8	.36	169.4	.59
N	$\bar{X}$	229.2	292.6	5.0	9.8	230.3	290.5	3.5	6.5	215.1	.73	198.9	.69
	R	11.4	16.8	4.5	5.6	26.9	22.2	5.2	12.1	82.0	.25	111.4	.38
P	$\bar{X}$	229.5	293.5	5.7	11.9	229.2	291.1	4.1	6.9	238.6	.81	213.4	.74
	R	20.9	22.7	4.0	22.5	21.1	27.1	4.5	10.6	62.3	.24	104.1	.33
S	$\bar{X}$	227.3	291.6	5.5	11.6	229.3	290.8	4.0	7.8	234.1	.80	211.6	.73
	R	17.3	14.3	4.7	17.6	14.9	28.2	5.5	13.6	94.5	.32	95.9	.32
T	$\bar{X}$	227.4	292.2	5.3	10.8	229.7	290.9	4.3	8.5	229.5	.78	215.1	.70
	R	11.3	15.0	3.8	14.4	15.0	14.5	4.5	12.5	69.4	.24	129.3	.43
V	$\bar{X}$	227.0	292.4	5.2	10.5	228.6	289.3	4.0	7.7	219.3	.75	204.5	.71
	R	11.3	17.4	3.0	8.0	17.0	32.1	6.0	13.8	52.3	.19	124.4	.39
Avgs.	$\bar{\bar{X}}$	230.6	295.3	5.1	10.6	231.7	292.2	3.5	6.6	244.1	.82	207.8	.72
	$\bar{R}$	16.0	17.9	5.0	17.0	18.6	27.9	5.5	12.6	78.3	.26	118.1	.40

TABLE VIII

STATISTICAL SUMMARY OF SMOOTH AND NOTCHED TENSILE TEST DATA FOR AIR MELT-DEGAS-VACUUM ARC REMELT HEAT W-24342-V1 COMPUTED BY BILLET SECTION

Billet Section	Statistical Value	SPECIMEN TYPE											
		SMOOTH								NOTCHED			
		LONGITUDINAL				TRANSVERSE				LONG.		TRANS.	
		F_{ty} KSI	F_{tu} KSI	% E.	% R.A.	F_{ty} KSI	F_{tu} KSI	% E.	% R.A.	F_{tu} KSI	N/S RATIO	F_{tu} KSI	N/S RATIO
A	$\bar{X}$	234.6	302.1	3.8	7.3	231.2	294.9	3.5	5.5	266.5	.88	211.2	.72
	R	15.8	13.5	3.0	8.7	21.7	24.0	4.5	9.9	88.0	.26	113.8	.42
B	$\bar{X}$	234.3	201.7	4.5	9.1	232.7	296.1	3.2	5.9	251.5	.83	201.9	.69
	R	18.8	24.9	5.3	13.4	19.7	31.2	5.5	9.6	75.0	.25	114.9	.39
C	$\bar{X}$	234.5	301.8	4.4	8.6	232.1	296.0	3.1	5.7	236.0	.78	204.5	.69
	R	21.6	32.5	6.0	17.7	26.5	26.2	5.3	12.3	106.0	.34	114.8	.36
D	$\bar{X}$	233.8	300.9	4.7	8.9	230.5	294.3	3.6	6.2	250.9	.84	195.7	.66
	R	15.8	24.0	3.8	17.0	24.2	28.7	4.7	10.3	68.0	.26	111.0	.41
E	$\bar{X}$	233.3	299.9	4.9	9.2	230.8	295.4	3.6	6.6	250.9	.84	204.7	.70
	R	20.5	31.3	6.0	19.3	17.5	20.7	5.0	11.9	38.0	.16	139.0	.47
H	$\bar{X}$	231.3	298.9	4.8	9.6	230.9	295.6	3.6	6.4	248.0	.83	214.9	.73
	R	14.5	20.5	4.5	11.6	20.0	19.2	4.5	10.3	80.2	.31	135.3	.45
I	$\bar{X}$	233.1	299.8	4.2	7.8	230.4	294.7	3.6	6.4	243.8	.82	211.0	.72
	R	20.2	32.3	4.0	9.4	22.5	28.0	4.7	12.4	95.9	.37	132.5	.44
J	$\bar{X}$	232.5	299.6	4.4	8.1	230.9	295.2	3.4	5.5	235.4	.79	191.1	.65
	R	16.5	25.2	4.2	11.7	18.2	22.3	4.0	8.5	92.9	.36	110.1	.40
K	$\bar{X}$	232.6	299.4	4.0	7.3	230.1	294.6	3.7	7.2	227.6	.76	211.5	.72
	R	21.7	27.6	3.8	11.0	20.2	26.3	5.5	12.9	93.1	.30	119.0	.41
L	$\bar{X}$	232.6	299.6	4.3	7.3	230.6	293.4	3.6	6.0	233.4	.78	220.1	.76
	R	12.7	19.2	4.1	10.6	20.0	51.0	4.8	9.7	79.0	.23	124.2	.43
M	$\bar{X}$	233.8	299.7	5.1	10.3	230.7	295.9	4.2	7.4	227.7	.78	205.5	.70
	R	9.7	18.9	5.2	19.0	21.5	26.1	6.0	13.9	94.1	.26	144.5	.48
N	$\bar{X}$	232.0	299.3	4.9	9.8	230.1	292.8	3.6	6.0	243.6	.81	206.1	.71
	R	14.9	19.4	5.5	18.2	28.3	32.9	5.7	12.2	72.0	.24	151.3	.51
P	$\bar{X}$	231.8	298.5	4.9	9.2	229.6	294.9	4.2	7.2	251.0	.84	223.7	.76
	R	24.3	19.0	6.3	16.7	22.6	24.5	5.3	13.1	58.1	.21	89.3	.36
S	$\bar{X}$	231.1	299.6	5.3	10.3	231.1	295.6	4.2	7.0	237.1	.79	218.5	.74
	R	15.3	24.7	4.7	10.6	24.7	26.5	6.0	16.9	81.0	.29	122.5	.41
T	$\bar{X}$	231.3	299.3	5.1	10.9	228.1	291.9	4.4	8.2	239.9	.80	214.2	.74
	R	7.2	11.7	4.5	17.6	19.8	20.7	7.2	14.3	89.5	.31	144.8	.50
V	$\bar{X}$	229.8	297.1	6.2	13.9	228.3	291.2	3.7	7.0	240.2	.80	203.7	.70
	R	18.8	33.1	6.0	18.5	16.6	36.0	5.8	12.2	101.7	.38	114.0	.40
Avgs.	$\bar{X}$	232.6	299.8	4.7	9.2	230.5	294.5	3.7	6.5	242.6	.81	208.6	.71
	$\bar{R}$	16.8	23.6	4.8	14.4	21.5	27.8	5.3	11.9	82.0	.28	123.8	.43

TABLE IX

STATISTICAL SUMMARY OF SMOOTH AND NOTCHED TENSILE TEST DATA FOR AIR MELT-DOUBLE VACUUM ARC REMELT HEAT W-24341-2 COMPUTED BY BILLET SECTION

Billet Section	Statistical Value	SPECIMEN TYPE											
		SMOOTH								NOTCHED			
		LONGITUDINAL				TRANSVERSE				LONG.		TRANS.	
		F_{ty} KSI	F_{tu} KSI	% E.	% R.A.	F_{ty} KSI	F_{tu} KSI	% E.	% R.A.	F_{tu} KSI	N/S RATIO	F_{tu} KSI	N/S RATIO
A	$\bar{X}$	228.5	300.9	3.8	6.9	229.2	291.3	2.7	5.3	251.1	.86	222.4	.79
	R	16.8	15.0	4.0	11.1	22.0	24.8	5.5	13.4	64.3	.35	103.4	.58
B	$\bar{X}$	226.3	297.0	4.5	8.6	228.4	293.5	2.7	4.7	237.0	.79	204.9	.71
	R	17.0	14.3	4.2	8.8	20.1	25.5	6.0	8.7	88.6	.28	121.1	.43
C	$\bar{X}$	228.5	299.8	4.1	7.8	227.6	283.4	2.2	3.9	247.8	.83	205.3	.71
	R	18.3	21.2	4.5	12.3	36.6	58.7	6.2	7.4	90.5	.30	102.3	.29
D	$\bar{X}$	226.8	297.3	3.3	6.2	226.5	285.9	2.2	4.1	244.8	.83	223.5	.79
	R	14.2	19.4	3.7	8.8	25.1	40.6	4.0	7.5	64.5	.22	131.0	.57
E	$\bar{X}$	230.6	304.1	4.5	8.1	229.9	293.3	2.4	3.9	248.1	.82	218.1	.76
	R	20.8	17.5	4.7	13.8	22.0	25.1	4.5	8.5	58.2	.20	118.0	.36
H	$\bar{X}$	230.8	302.8	3.6	6.6	230.4	290.8	1.9	3.6	234.8	.78	192.9	.66
	R	20.1	14.2	6.5	9.1	16.0	35.7	3.0	4.7	103.5	.16	179.7	.61
I	$\bar{X}$	230.0	300.4	3.3	6.3	229.9	292.2	1.9	3.6	259.0	.86	206.8	.71
	R	16.4	25.2	6.0	15.3	30.6	44.0	4.5	6.2	82.4	.26	147.8	.50
J	$\bar{X}$	222.7	291.0	3.4	6.7	228.0	287.7	1.8	3.7	237.3	.81	218.1	.76
	R	19.0	21.2	5.0	9.6	23.6	45.7	2.7	5.5	86.9	.24	118.0	.36
K	$\bar{X}$	227.6	292.7	3.1	5.3	227.7	288.3	1.7	3.6	256.8	.88	230.3	.79
	R	21.3	36.3	7.0	8.8	18.8	33.2	3.0	5.7	64.4	.28	85.9	.28
L	$\bar{X}$	228.8	301.8	4.5	8.1	230.8	290.7	1.8	3.3	255.0	.85	220.3	.75
	R	17.6	26.7	5.5	10.5	23.8	28.4	2.7	3.7	70.2	.26	128.6	.45
M	$\bar{X}$	230.0	300.6	4.6	8.6	230.2	292.2	1.9	3.9	247.4	.83	193.9	.67
	R	9.0	18.9	5.5	16.1	21.8	32.4	3.0	7.2	71.0	.25	161.9	.54
N	$\bar{X}$	229.0	300.7	3.9	8.0	228.8	293.2	1.9	3.5	239.7	.79	207.4	.71
	R	15.3	15.7	5.5	16.6	28.3	31.0	2.7	6.3	123.0	.41	145.7	.51
P	$\bar{X}$	228.7	303.6	5.1	9.0	230.8	290.8	2.1	3.9	257.9	.85	235.2	.81
	R	16.0	18.1	4.8	15.8	17.0	35.0	3.2	8.9	69.0	.21	92.9	.29
S	$\bar{X}$	229.7	301.6	3.8	6.3	230.2	292.8	2.3	4.2	268.3	.89	196.3	.68
	R	12.3	21.8	5.0	11.8	18.0	55.6	4.1	6.6	39.4	.14	91.5	.26
T	$\bar{X}$	232.8	306.5	5.0	10.5	232.7	297.2	2.2	3.7	248.9	.82	204.9	.69
	R	21.3	18.1	5.7	20.1	27.5	28.8	5.5	13.0	53.5	.18	155.1	.54
V	$\bar{X}$	233.4	308.4	5.4	11.7	235.8	304.4	2.7	4.7	256.3	.82	238.0	.79
	R	24.4	21.2	5.7	18.3	19.5	27.8	4.8	9.2	69.2	.26	80.6	.33
Avgs.	$\bar{\bar{X}}$	229.0	300.6	4.1	7.8	229.8	291.7	2.2	4.0	249.4	.83	213.6	.74
	$\bar{R}$	17.5	20.3	5.2	12.9	23.2	35.8	4.1	7.7	74.9	.25	120.7	.43

TABLE X

STATISTICAL SUMMARY OF SMOOTH AND NOTCHED TENSILE TEST DATA FOR VACUUM INDUCTION MELT-VACUUM ARC REMELT HEAT W-24403-1 COMPUTED BY BILLET SECTION

Billet Section	Statistical Value	SPECIMEN TYPE											
		SMOOTH								NOTCHED			
		LONGITUDINAL				TRANSVERSE				LONG.		TRANS.	
		F_{ty} KSI	F_{tu} KSI	% E.	% R.A.	F_{ty} KSI	F_{tu} KSI	% E.	% R.A.	F_{tu} KSI	N/S RATIO	F_{tu} KSI	N/S RATIO
A	$\bar{X}$	230.5	297.3	6.7	15.6	230.7	296.1	6.3	13.8	293.4	.99	272.4	.92
	R	15.0	19.1	4.5	15.4	11.6	16.0	6.5	23.1	94.5	.32	87.5	.31
B	$\bar{X}$	229.3	295.4	6.6	15.2	230.8	297.1	6.2	13.4	268.7	.91	237.1	.81
	R	8.5	24.9	4.0	12.5	10.9	31.3	5.0	21.1	89.5	.25	69.7	.23
C	$\bar{X}$	230.6	296.5	6.6	14.6	230.1	295.4	6.0	12.2	283.7	.96	228.0	.77
	R	17.1	26.3	5.3	20.3	18.9	13.8	5.3	16.4	51.8	.14	84.1	.33
D	$\bar{X}$	231.2	296.9	6.3	13.6	229.5	295.3	6.0	12.5	270.6	.91	218.4	.74
	R	13.1	24.1	4.0	16.5	16.7	19.4	4.8	15.8	62.4	.32	93.0	.32
E	$\bar{X}$	229.8	297.3	5.7	13.1	229.7	294.8	5.4	11.5	254.1	.86	237.5	.81
	R	12.8	22.3	3.8	15.8	14.2	17.9	6.0	17.8	78.8	.37	95.0	.31
H	$\bar{X}$	228.8	296.8	5.9	13.5	229.4	292.3	5.4	11.6	264.2	.88	229.8	.79
	R	12.3	23.8	5.0	8.5	14.3	47.2	7.0	20.2	93.6	.27	147.8	.51
I	$\bar{X}$	231.1	297.3	5.6	11.1	229.5	294.2	5.6	11.8	253.9	.85	247.8	.84
	R	23.2	16.5	3.5	13.3	17.6	26.8	6.2	17.1	73.8	.20	49.7	.18
J	$\bar{X}$	230.3	296.7	6.4	13.7	230.1	295.1	6.0	12.2	253.3	.85	224.9	.76
	R	14.6	18.0	3.5	8.8	11.5	15.0	5.0	14.5	91.7	.28	85.5	.31
K	$\bar{X}$	229.4	293.0	6.3	14.5	228.4	293.8	5.8	12.0	273.9	.94	229.9	.78
	R	10.0	17.2	5.3	14.5	12.3	19.3	6.8	17.2	77.3	.24	112.8	.37
L	$\bar{X}$	227.7	293.4	5.8	12.3	228.3	294.1	6.3	13.6	252.3	.86	239.8	.81
	R	9.3	24.9	3.5	11.7	18.1	31.4	5.5	17.8	65.1	.22	128.4	.44
M	$\bar{X}$	227.9	291.8	6.4	13.6	228.4	293.0	6.1	13.3	248.8	.86	237.1	.81
	R	8.6	14.2	4.5	17.1	12.9	13.0	5.5	16.5	82.5	.28	71.8	.22
N	$\bar{X}$	228.4	293.0	6.2	14.0	227.9	291.2	5.9	12.7	253.7	.86	226.1	.77
	R	11.4	14.4	2.5	9.9	13.4	24.6	6.5	17.2	99.7	.25	95.9	.32
P	$\bar{X}$	227.6	292.6	6.1	13.0	227.5	291.6	6.0	12.9	261.0	.89	239.7	.82
	R	10.2	10.4	5.5	12.2	16.7	12.7	5.5	14.8	67.7	.16	84.5	.30
S	$\bar{X}$	227.8	293.4	6.1	13.2	227.4	292.2	6.5	14.4	244.5	.84	226.5	.78
	R	12.1	12.5	2.8	8.9	16.8	14.4	4.5	14.8	89.6	.29	102.8	.32
T	$\bar{X}$	227.4	291.9	6.0	12.8	226.4	290.9	6.3	13.5	255.8	.88	233.1	.80
	R	12.0	10.9	2.7	10.3	16.3	19.2	4.5	12.3	96.6	.36	101.9	.34
V	$\bar{X}$	229.5	294.2	6.5	14.3	228.8	292.7	6.7	15.7	240.8	.82	249.1	.85
	R	10.8	11.2	3.0	16.5	13.6	5.1	5.0	16.5	43.9	.17	56.3	.19
Avgs.	$\bar{X}$	229.2	294.9	6.2	13.6	229.0	293.8	6.0	12.9	260.8	.89	236.1	.80
	$\bar{R}$	12.6	18.2	4.0	13.3	14.7	20.4	5.6	17.1	78.7	.26	91.7	.31

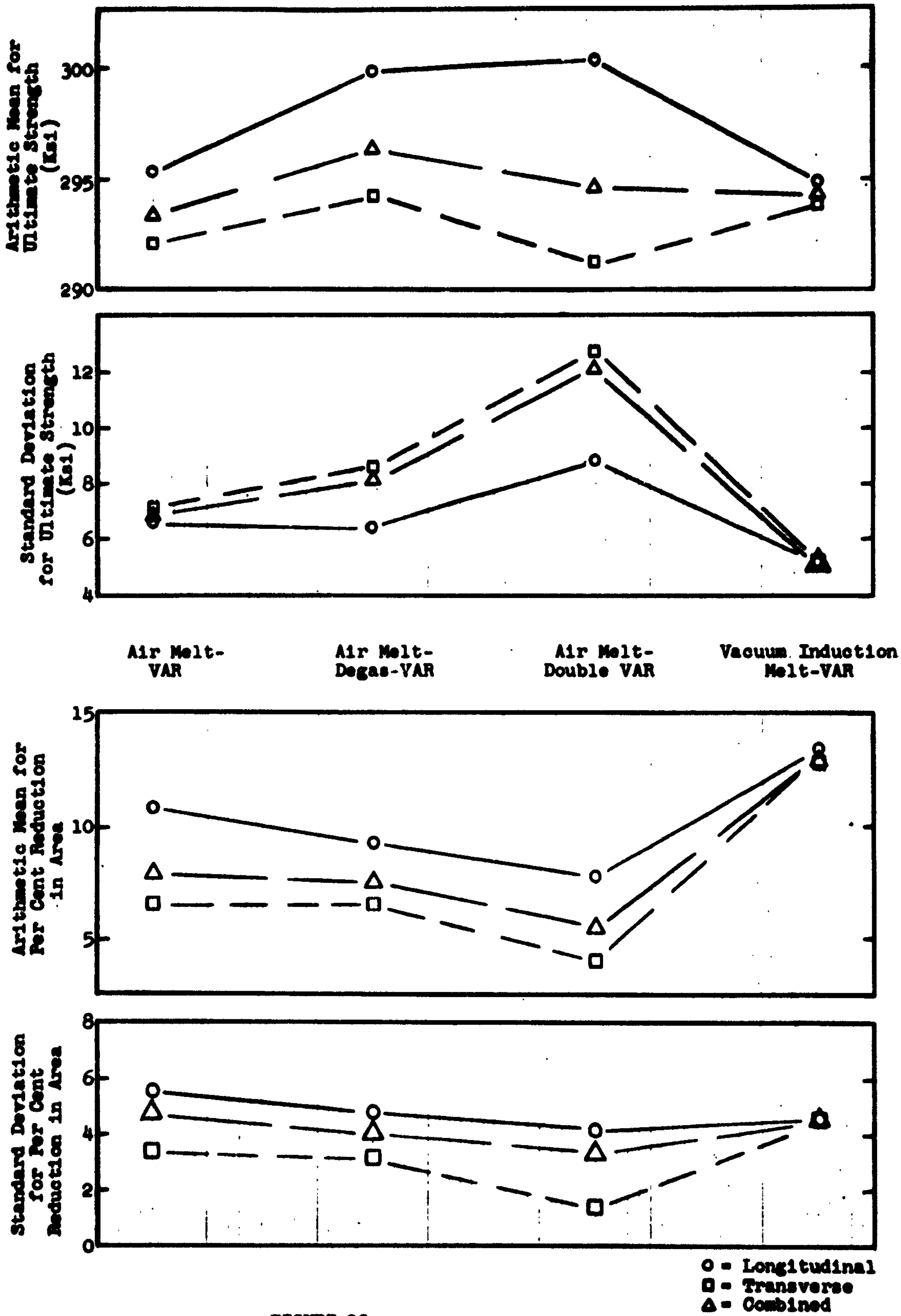


FIGURE 20

MELT PROCESS COMPARISON -- MEAN AND STANDARD DEVIATION FOR ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- VALUES BASED UPON SMOOTH TENSILE TEST RESULTS PLOTTED FOR TRANSVERSE, LONGITUDINAL, AND COMBINED DIRECTIONS

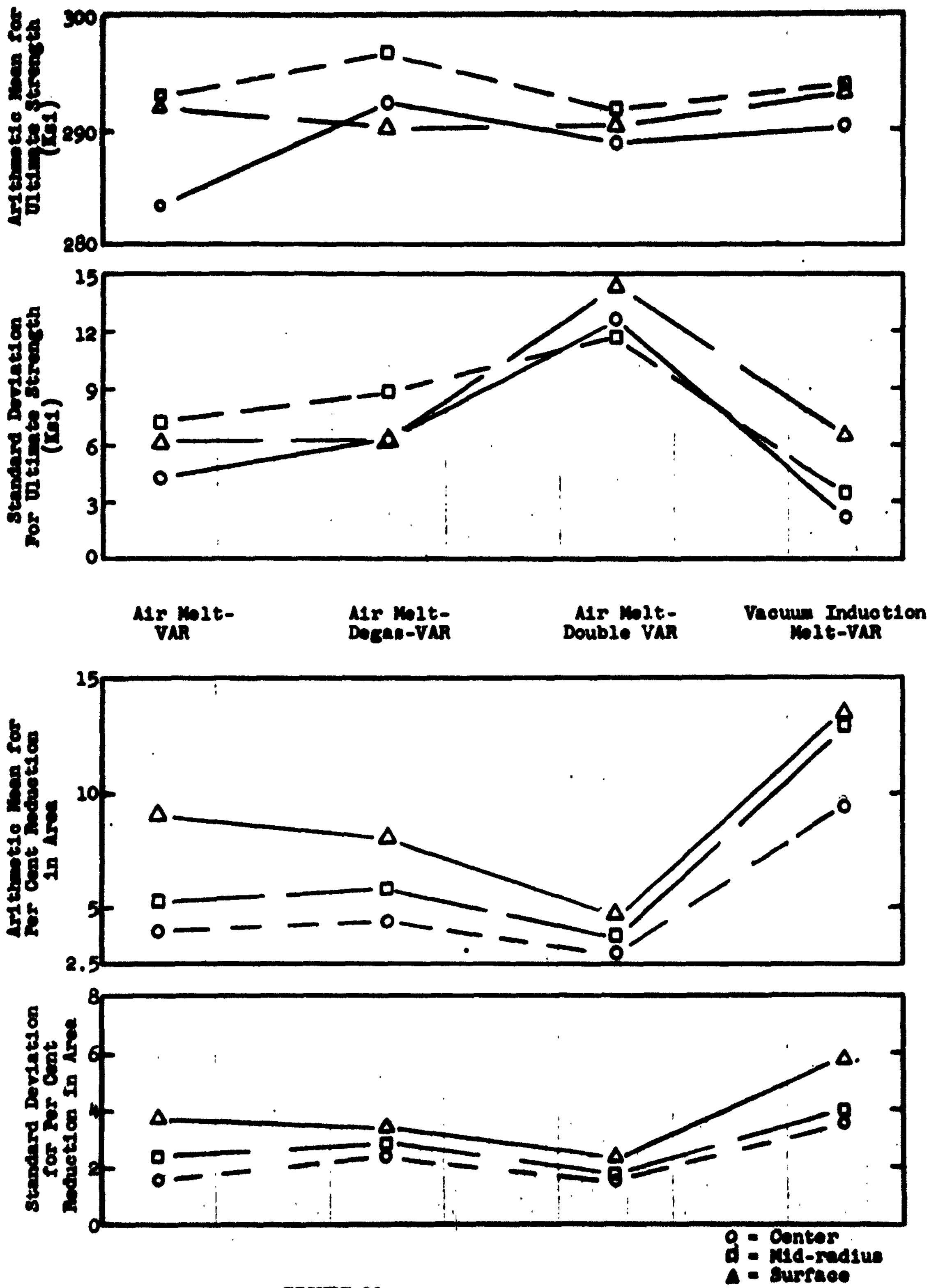


FIGURE 21

MELT PROCESS COMPARISON -- MEAN AND STANDARD DEVIATION FOR ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- VALUES BASED UPON SMOOTH TRANSVERSE TENSILE TEST RESULTS PLOTTED FOR SURFACE, MID-RADIUS, AND CENTER POSITIONS

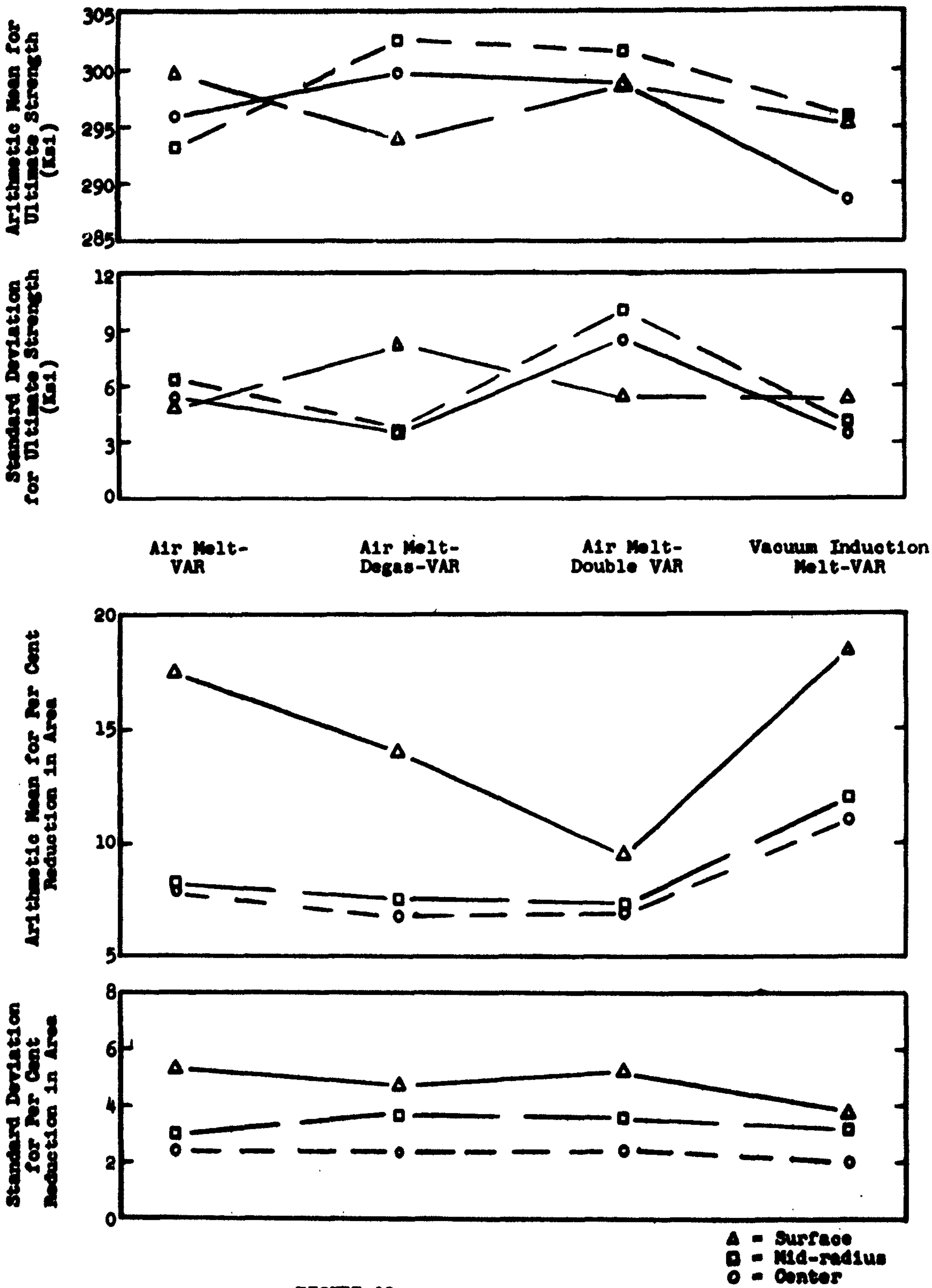


FIGURE 22

MELT PROCESS COMPARISON -- MEAN AND STANDARD DEVIATION FOR ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- VALUES BASED UPON SMOOTH LONGITUDINAL TENSILE TEST RESULTS PLOTTED FOR SURFACE, MID-RADIUS, AND CENTER POSITIONS

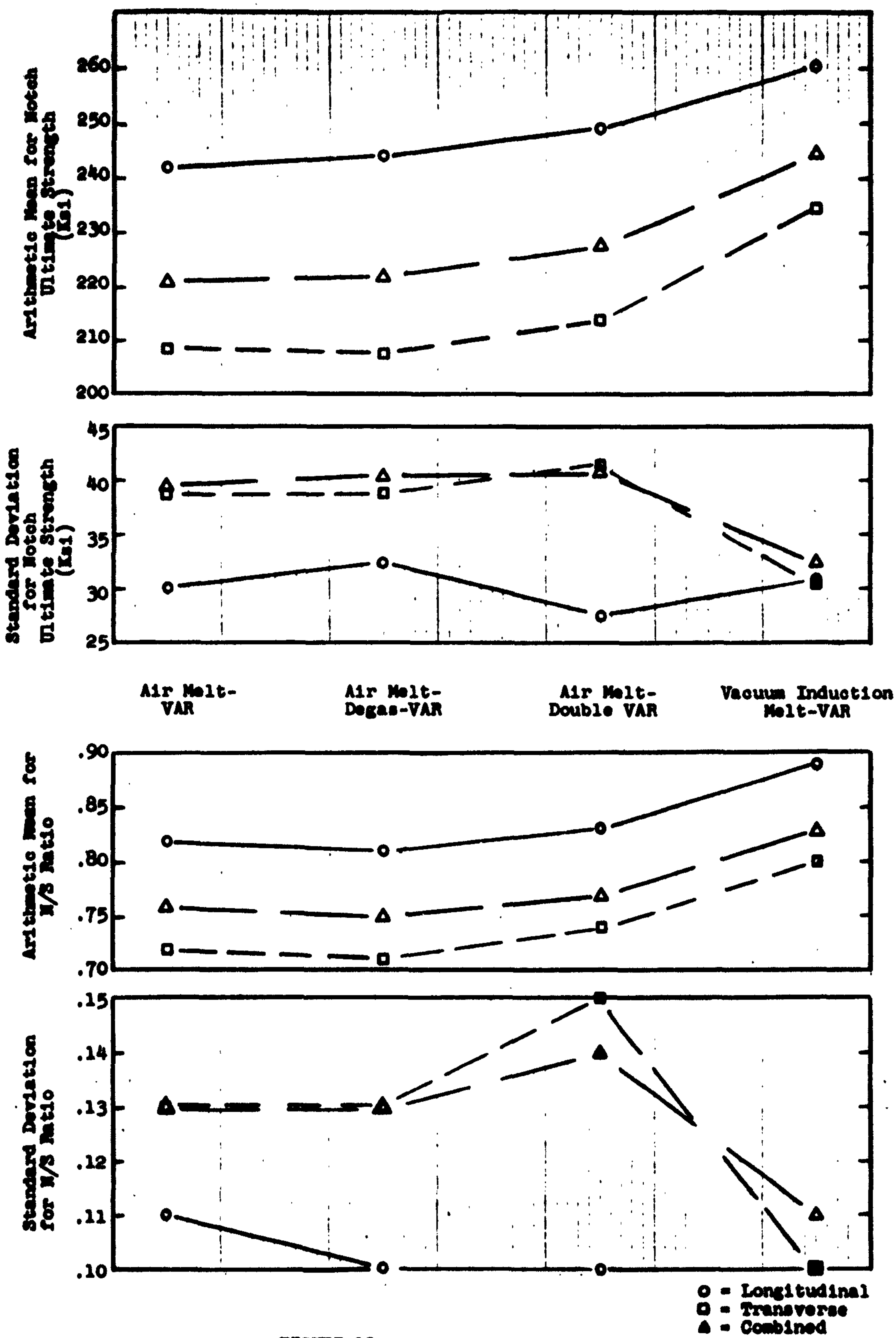


FIGURE 23

MELT PROCESS COMPARISON -- MEAN AND STANDARD DEVIATION FOR NOTCH STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- VALUES BASED UPON TENSILE TEST RESULTS PLOTTED FOR TRANSVERSE, LONGITUDINAL, AND COMBINED DIRECTIONS

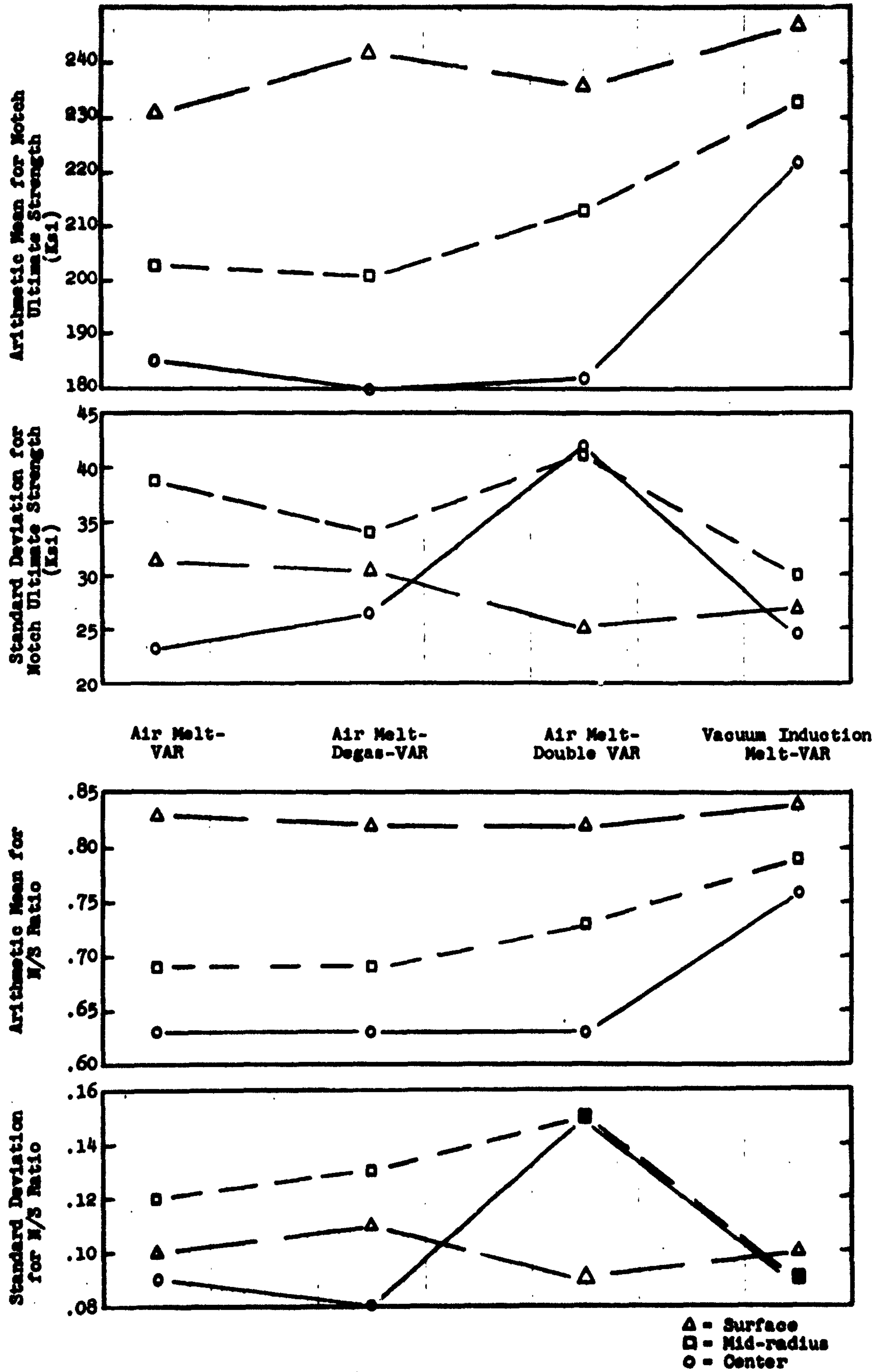


FIGURE 24

MELT PROCESS COMPARISON -- MEAN AND STANDARD DEVIATION FOR NOTCH STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- VALUES BASED UPON TRANSVERSE TENSILE TEST RESULTS PLOTTED FOR SURFACE, MID-RADIUS, AND CENTER POSITIONS

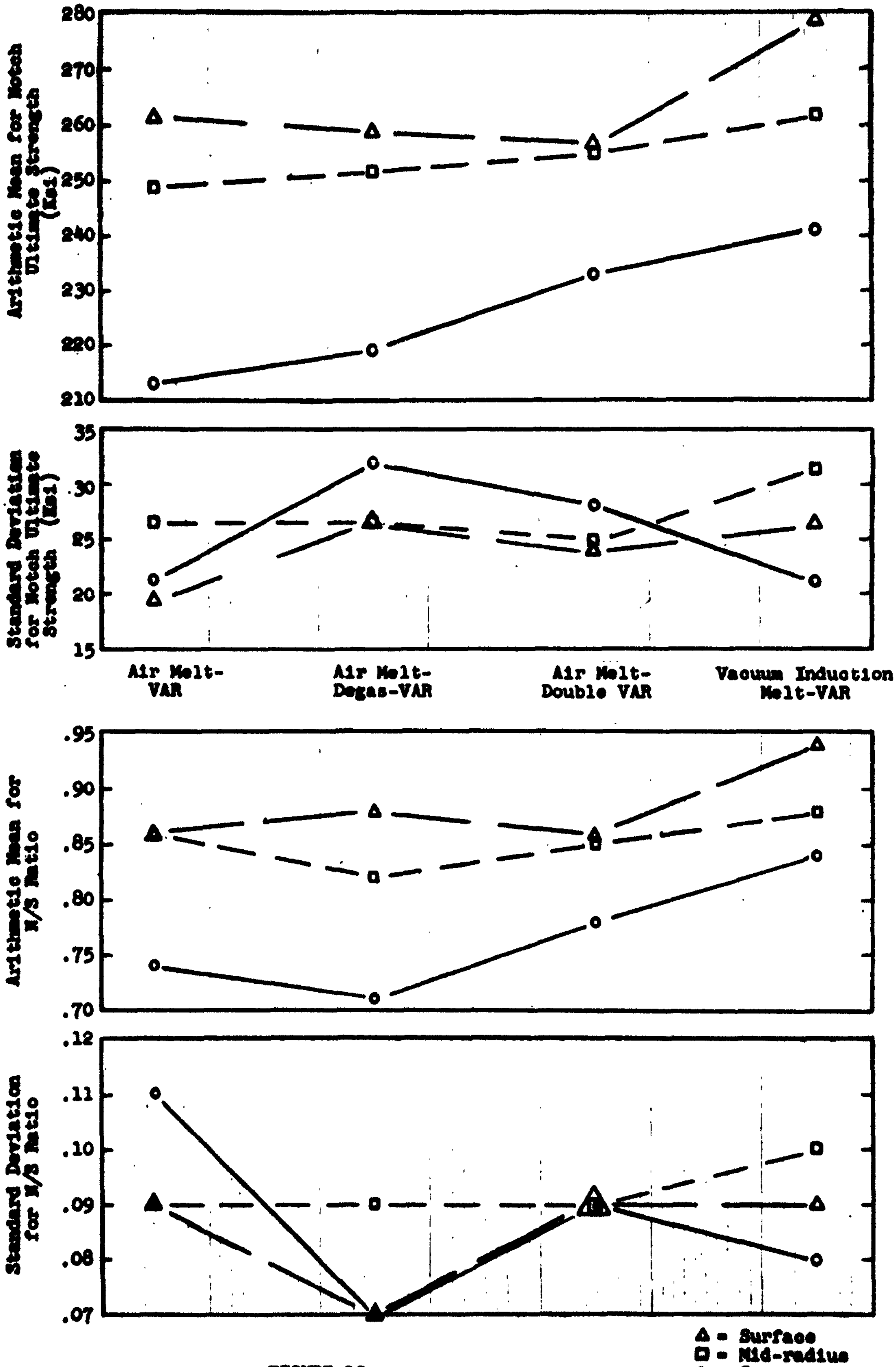


FIGURE 25

MELT PROCESS COMPARISON -- MEAN AND STANDARD DEVIATION FOR NOTCH STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- VALUES BASED UPON LONGITUDINAL TENSILE TEST RESULTS PLOTTED FOR SURFACE, MID-RADIUS, AND CENTER POSITIONS

to highlight the relationships between process variation and property data.

Figure 26 provides an additional measure of comparison. The $\bar{X}$ and σ values for smooth and notched specimen strength and ductility from each process variation are translated into a coefficient of variation$\left(\frac{\sigma}{\bar{X}}\right)$. This approach combines values for mean and standard deviation into a single value for a more effective comparison. The preferred condition is one with a low coefficient of variation, since a low value generally implies a relatively low standard deviation or spread in the variation of the property value under investigation.

Comparing overall smooth and notched ultimate strength distributions included in Appendix V for each of the four melting process variations, it is noted that all figures exhibit reasonably normal-appearing histogram plots with the exception of that for notched air melt-double VAR data, Figure 5-46, which tends to skew toward the lower strength values. Similarly, the overall distributions for the notched/smooth ultimate strength ratio exhibit normal-appearing histograms with the exception, again, of that for the air melt-double VAR data.

A comparison of per cent reduction in area on the same basis shows that only the vacuum induction melt-VAR figures tend to display normal-appearing histogram plots, while those for the remaining three process variations all exhibit a skewness toward the lower end of the range.

Further similarities or differences in the distributions of test

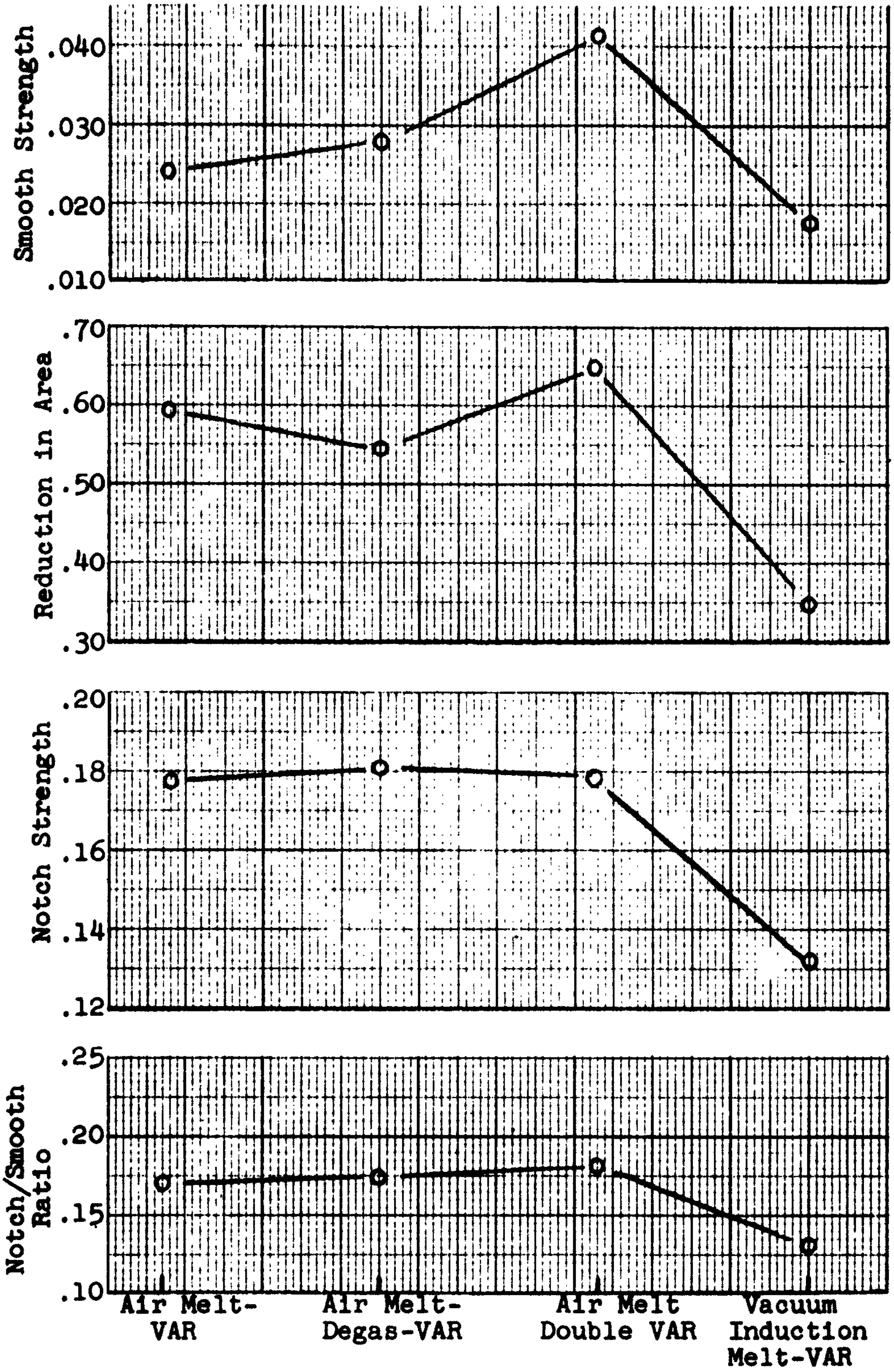


FIGURE 26

MELT PROCESS COMPARISON BY MEANS OF COEFFICIENT OF VARIATION ($\frac{\sigma}{\bar{X}}$) PLOTTED FOR ULTIMATE STRENGTH, PER CENT REDUCTION IN AREA, NOTCH STRENGTH, AND NOTCH/SMOOTH STRENGTH RATIO

data statistically evaluated may be observed by viewing appropriate histogram plots and calculated statistical criteria presented in Appendix V figures.

Evaluation of the 12 control charts in Appendix VI which depict the mean and range values for tensile properties in each section of the air melt-VAR billet disclosed the following information:

1. Smooth transverse $\bar{X}$ values for yield strength, Figure 6-1, and ultimate strength, Figure 6-2, are out of control at the top portion of the billet.

2. Smooth longitudinal $\bar{X}$ values for yield strength, Figure 6-5, and ultimate strength, Figure 6-6, are also out of control at the top portion of the billet.

3. A definite downward trend in $\bar{X}$ values for both transverse and longitudinal yield and ultimate strength from top to bottom of the billet is noted in Figures 6-1, 6-2, 6-5, and 6-6.

4. Transverse elongation, Figure 6-3, and reduction in area, Figure 6-4, indicate a definite upward trend in $\bar{X}$ values even though all are within control over the full length of the billet.

5. Range values for all air melt-VAR conditions are essentially within control limits. Two exceptions are a single billet section for smooth transverse ultimate strength, Figure 6-2, and smooth longitudinal yield strength, Figure 6-5, in both

of which the upper control limit is slightly exceeded.

6. Further evidence of a significant difference between top and bottom portions of the billet is demonstrated in Figures 6-1, 6-5, 6-6, 6-11, and 6-12 wherein eight or more consecutive billet section $\bar{X}$ values may be observed on the same side of the overall average. The probability of this occurring due to chance alone is 0.0039, or approximately four times in a thousand. The occurrence, therefore, strongly suggests a significant change in melt process control.

Evaluation of the 12 Appendix VI control charts depicting mean and range values in each section of the air melt-degas-VAR billet disclosed the following:

1. Longitudinal per cent elongation, Figure 6-19, and reduction in area, Figure 6-20, each indicate an out-of-control $\bar{X}$ value above the upper control limit at the extreme bottom billet section, while corresponding yield strength, Figure 6-17, and ultimate strength, Figure 6-18, although in control, exhibit the lowest $\bar{X}$ values for the entire billet.

2. A tendency to develop higher than average transverse and longitudinal yield and ultimate strength $\bar{X}$ values at the top of the billet and lower than average values at the bottom of the billet may be observed in Figures 6-13, 6-14, 6-17, and 6-18. An inverse tendency is indicated for transverse and longitudinal per cent elongation and reduction in area in Figures 6-15, 6-16, 6-19, and 6-20.

3. Range values for all conditions plotted are within their respective control limits with but a single exception, a mid-length billet section value for smooth transverse ultimate strength as shown in Figure 6-14.

4. The recurrence of eight or more consecutive billet section averages on the same side of the $\bar{X}$ chart mean for transverse per cent elongation, Figure 6-15, and longitudinal ultimate strength, Figure 6-18, indicates a significant difference between top and bottom values of the billet.

Evaluation of the 12 control charts in Appendix VI for the air melt-double VAR billet indicated the following information:

1. All smooth transverse properties except per cent elongation, Figure 6-27, and all smooth longitudinal properties exhibited out-of-control values above or below (in some instances both above and below) the billet average in various sections along the billet length.

2. Out-of-control range values exceed the upper control limits for all smooth transverse properties with other values closely approaching this limit. Only one value for smooth longitudinal properties, Figure 6-30, exceeds an upper control limit.

3. All notch properties for both longitudinal and transverse directions are within control limits on both $\bar{X}$ and R charts.

4. The lowest $\bar{X}$ values for all smooth longitudinal properties

occur at the middle of the billet length.

5. The significant difference between the center of the billet and the top and bottom ends is highlighted by the $\bar{X}$ charts for smooth transverse per cent elongation, Figure 6-27, and per cent reduction in area, Figure 6-28. Eight or more consecutive billet section averages fall below the billet average.

Evaluation of the final 12 control charts for vacuum induction melt-VAR billet provided the following information:

1. All of the smooth transverse $\bar{X}$ charts, Figures 6-37, 6-38, 6-40, 6-45, and 6-46, with the exception of per cent elongation, Figure 6-39, display one value out of control at either the top or bottom of the billet.

2. A definite downward trend in $\bar{X}$ values for smooth transverse yield strength, Figure 6-37, ultimate strength, Figure 6-38, smooth longitudinal yield strength, Figure 6-41, and ultimate strength, Figure 6-42, as well as notched longitudinal ultimate strength, Figure 6-47, is observable from top to bottom of the billet.

3. Range values for all R charts are within control limits, except for one smooth transverse ultimate strength value, Figure 6-38, and one smooth longitudinal yield strength value, Figure 6-41. Both indicate an excessively wide range at a billet location approximately one-third of the billet length from the top.

4. Significant differences from top to bottom of the billet are evident in the $\bar{X}$ charts for smooth transverse yield strength, Figure 6-37, smooth longitudinal ultimate strength, Figure 6-42, and in the R chart for smooth longitudinal yield strength, Figure 6-41. All three charts exhibit eight consecutive values on the same side of their respective overall average lines.

Evaluation of the statistical data presented in Tables III through VI and subsequently plotted in Figures 20 through 26 for transverse and longitudinal smooth and notched tensile specimens from surface, mid-radius, and center positions in each billet disclosed the following information:

1. Considering the average ultimate strength of all smooth specimens from each billet, Figure 20, considerable uniformity is evidenced for all melting techniques. Average smooth strength ranged from a low of 293.3 Ksi for the air melt-VAR billet to a high of 296.4 Ksi for the air melt-degas-VAR billet.

2. Average longitudinal ultimate strength, Figure 20, exceeded average transverse ultimate strength by only 0.4 per cent in vacuum induction melt-VAR material and by 3.1 per cent in air melt-double VAR material.

3. The mid-radius position yielded higher average ultimate strengths than center and surface locations with the exception of longitudinal specimens from the air melt-VAR

billet as can be seen by comparing Figures 21 and 22. Mid-radius longitudinal specimens from the air melt-VAR billet averaged lower than comparable surface or center specimens. The highest average longitudinal ultimate strength for the air melt-VAR heat, 299.7 Ksi, was found at the surface location. The value for the mid-radius position is 293.2 Ksi. In the transverse direction, mid-radius and surface averages in the air melt-VAR billet were essentially the same, 293.3 and 292.2 Ksi, respectively.

4. The coefficient of variation $(\frac{\sigma}{\bar{X}})$ for smooth ultimate strength shown in Figure 26 ranges from .018 for vacuum induction melt-VAR material to .042 for the air melt-double VAR billet. Since the coefficient is a measure of variation per unit measured, the uniformity of the heat treat response of the vacuum induction melt-VAR material is shown to be markedly superior to that demonstrated by the other three materials.

5. As shown in Figure 20, the ductility of vacuum induction melt-VAR material (as measured by per cent reduction in area) is significantly superior to that provided by the other three process variations. The average value for all smooth specimens from each heat is as follows:

	% R.A.
Vacuum induction melt-VAR	13.2
Air melt-VAR	8.1
Air melt-vacuum degas-VAR	7.5
Air melt-double VAR	5.1

Thus, the average ductility of the vacuum induction melt-VAR billet is 63 per cent higher than the air melt-VAR billet, 76 per cent higher than the vacuum degassed billet, and 144 per cent higher than the double VAR-processed air melt heat.

6. Longitudinal ductility (in per cent reduction in area) exceeded transverse ductility, as shown in Figure 20, by only 5.4 per cent in the vacuum induction melt-VAR material, but the degree of directionality increases to 110 per cent for the double VAR-melted billet.

7. The surface of the billets provided the highest reduction in area values in both longitudinal and transverse directions as indicated in Figures 22 and 21. All mid-radius averages exceeded comparable center-of-the-billet values in both directions.

8. The coefficient of variation, Figure 26, for per cent reduction in area, ranged from .35 for vacuum induction melt-VAR material to .65 for the air melt-VAR material. The reduction in area for the vacuum induction melt-VAR billet is high compared to the other melt practices. The low coefficient of variation value indicates considerably less variation in ductility than shown by the other three melt practices.

9. Based upon the average notch tensile strength for all notched specimens from each billet, notch tensile strength

in the vacuum induction melt-VAR heat is 7.1 per cent higher than that in the air melt-double VAR heat, 9.4 per cent higher than that in vacuum degassed-VAR heat, and 9.7 per cent higher than that in the air melt-VAR heat, as shown in Figure 23.

10. Figure 23 also shows that longitudinal notch strength ranges from 11.7 per cent to 17.5 per cent higher than transverse notch strength for vacuum induction melt-VAR and air melt-degassed-VAR materials, respectively.

11. Figure 24 and Figure 25 evidence the fact that notch tensile strength is substantially lower at the center of the billet than at mid-radius or surface locations. For transverse specimens, the surface position provides the highest notch strength averages ranging from 11.8 to 36.9 per cent higher than corresponding center averages in vacuum induction melt-VAR and air melt-degas-VAR materials, respectively. The surface position also provides the highest notch tensile strengths in longitudinal specimens.

12. The coefficient of variation for notch tensile strength, Figure 26, indicates that the air melt-vacuum arc remelt process variations (including the vacuum degassed and the double VAR-processed billets) are essentially equal in regard to degree of variation. On the other hand, the vacuum induction melt-VAR billet, with a coefficient of variation 34.5 per cent lower than the air melt-VAR billet and 38

per cent lower than the vacuum degassed-VAR material, provides considerably greater uniformity in notch strength.

13. As displayed in Figure 23, the notch/smooth strength ratio for the vacuum induction melt-VAR billet is 7.8 per cent higher than that for the air melt-double VAR billet, 9.3 per cent higher than that for the air melt-VAR billet, and 10.7 per cent higher than the vacuum degas-VAR billet overall N/S ratio.

14. For all four process variations the N/S ratio for the longitudinal direction is higher than the transverse N/S ratio. The difference is least in the vacuum induction melt-VAR billet (11.2 per cent) and greatest in the vacuum degas-VAR billet (14.1 per cent), on the basis of values plotted in Figure 23.

15. The N/S ratio is appreciably lower at the center of the billets than at mid-radius and surface. Surface N/S ratios for the transverse direction range from 10.5 per cent (induction melt-VAR) to 31.8 per cent (air melt-VAR) higher than corresponding averages at the center of the billet, as plotted in Figure 24. Surface N/S ratios in the longitudinal direction (Figure 25) range from 10.2 to 24 per cent higher than corresponding center values for the air melt-double VAR and the vacuum degas-VAR billets, respectively. In the vacuum induction melt-VAR billet, the surface N/S ratio is 11.8 per cent higher than the center N/S ratio.

16. The coefficient of variation for the N/S ratio shows that air melt-VAR, air melt-degas-VAR, and air melt-double VAR billets are essentially equal with respect to the degree of variation in the N/S ratio. The coefficient of variation for vacuum induction melt-VAR material is 22.8 per cent lower than the coefficient of variation for air melt-VAR material and 27.5 per cent lower than coefficient of variation for air melt-double VAR material.

V. CONCLUSIONS

Based upon overall heat averages for each of the four vacuum arc remelt process variations investigated, the following conclusions have been derived from statistical and metallurgical evaluation of smooth and notch tensile test data obtained from 3712 specimens processed and tested under rigidly-controlled conditions:

1. Of the four processes evaluated, the vacuum induction melt-VAR practice produced the highest quality product from the standpoint of maximum ductility in smooth specimens and least sensitivity to a notched condition, when heat treated for a 300 Ksi strength level.

2. The air melt-VAR material ranked second in overall property response and uniformity, although at a markedly lower level than the vacuum induction melt-VAR material.

3. The air melt-vacuum degas-VAR and air melt-double VAR processed billets of H-11 steel ranked third and fourth in that order; however, the level of quality for these processes is not appreciably lower than air melt-VAR processed material in most comparisons.

4. The vacuum induction melt-VAR material greatly reduces the influence of directionality on smooth and notch tensile properties. Transverse ductility values closely approach those obtained from longitudinal specimens, thereby achieving one of the major aims of the program (to be verified subsequently for actual parts forged in closed dies during Phase IV).

The following conclusions relating to the influence of test direction and cross-sectional location, particularly with respect to the resultant degree of overall property uniformity obtained, were derived from the statistical analysis of ultimate strength values developed from tensile tests of smooth specimens:

1. Considering the average ultimate strength of all smooth specimens from each billet, considerable uniformity is evidenced for all melting techniques. Average smooth strength ranged from a low of 293.3 Ksi for the air melt-VAR billet to a high of 296.4 Ksi for the air melt-degas-VAR billet.

2. Average longitudinal ultimate strength exceeded average transverse ultimate strength by only 0.4 per cent in vacuum induction melt-VAR material and by 3.1 per cent in air melt-double VAR material.

3. The mid-radius location in billet cross section consistently yielded higher ultimate strength averages than center and surface locations with the exception of the longitudinal specimen average for air melt-VAR material.

4. The comparison of coefficient of variation values for ultimate strength indicate that the highest degree of heat treat response uniformity was attained in the vacuum induction melt-VAR material.

The following conclusions relating to test direction, cross-

sectional location, and overall property uniformity were derived from the statistical analysis of smooth specimen ductility as measured by per cent reduction of area:

1. The ductility of vacuum induction melt-VAR material (as measured by per cent reduction of area at the 300 Ksi strength level) is significantly superior to that provided by the other three process variations. The average ductility of the vacuum induction melt-VAR billet is 63 per cent higher than the air melt-VAR billet, 76 per cent higher than the vacuum degassed-VAR billet, and 144 per cent higher than the double VAR-processed air melt heat.

2. Longitudinal ductility (in per cent reduction in area) exceeded transverse ductility by only 5.4 per cent in the vacuum induction melt-VAR material, but the degree of directionality increases to 110 per cent for the double VAR-melted billet.

3. Surface specimens consistently provided the highest reduction in area values in both longitudinal and transverse directions. Mid-radius averages exceeded comparable center-of-the-billet values in both directions.

4. The coefficient of variation for per cent reduction in area ranged from .35 for vacuum induction melt-VAR material to .65 for the air melt-VAR material. The low value for the vacuum induction melt-VAR billet indicates considerably less variation in ductility than shown by the other three melt practices.

The following conclusions were derived from the evaluation of notch tensile strength averages for each melt process as related to test direction, cross-sectional location, and property uniformity:

1. Based upon the average notch tensile strength of all notched specimens from each billet, notch tensile strength in the vacuum induction melt-VAR heat is 7.1 per cent higher than in the air melt-double VAR heat, 9.4 per cent higher than in the vacuum degassed-VAR heat, and 9.7 per cent higher than in the air melt-VAR heat.

2. Longitudinal notch strength ranges from 11.7 per cent to 17.5 per cent higher than transverse notch strength (vacuum induction melt-VAR and air melt-degassed-VAR materials, respectively).

3. Notch tensile strength is substantially lower at the center of each billet than at mid-radius or surface locations. For transverse specimens, the surface position provides the highest notch strength averages ranging from 11.8 to 36.9 per cent higher than corresponding center averages (vacuum induction melt-VAR and air melt-degas-VAR materials, respectively). The surface position also provides the highest notch tensile strengths in longitudinal specimens.

4. The coefficient of variation for notch tensile strength indicates that the three air melt-vacuum arc remelt process variations are essentially equal in regard to degree of

variation. On the other hand, the vacuum induction melt-VAR billet, with a coefficient of variation 34.5 per cent lower than the air melt-VAR billet and 38 per cent lower than the vacuum degassed-VAR material, provides considerably greater uniformity in notch strength than the other three processes.

Comparison of the notch/smooth ultimate strength ratio for each melt process as related to test direction, cross-sectional location, and property uniformity established the following conclusions:

1. The notch/smooth strength ratio for the vacuum induction melt-VAR billet is 7.8 per cent higher than for the air melt-double VAR billet, 9.3 per cent higher than for the air melt-VAR billet, and 10.7 per cent higher than the vacuum degas-VAR billet overall N/S ratio. The highest average N/S ratio obtained was .94 for longitudinal surface specimens in vacuum induction-vacuum arc remelt material.

2. For all four process variations, the N/S ratio for the longitudinal direction is higher than the transverse N/S ratio. The difference is least in the vacuum induction melt-VAR billet (11.2 per cent) and greatest in the vacuum degas-VAR billet (14.1 per cent).

3. The N/S ratio is appreciably lower at the center of the billets than at mid-radius or surface. Surface N/S ratios for the transverse direction range from 10.5 per cent (induction melt-VAR) to 31.8 per cent (air melt-VAR)higher

than corresponding averages at the center of the billet. Surface N/S ratios in the longitudinal direction range from 10.2 to 24 per cent higher than corresponding center values for the air melt-double VAR and the vacuum degas-VAR billets, respectively. In the vacuum induction melt-VAR billet, the surface N/S ratio is 11.8 per cent higher than the center N/S ratio.

4. The coefficient of variation for the N/S ratio shows that air melt-VAR, air melt-degas-VAR, and air melt-double VAR billets are essentially equal with respect to the degree of variation in average N/S ratio. The coefficient of variation for vacuum induction melt-VAR material is 22.8 per cent lower than the coefficient of variation for air melt-VAR material and 27.5 per cent lower than coefficient of variation for air melt-double VAR material.

The following conclusions were derived from an evaluation of the frequency distributions (histogram plots) contained in Appendix V:

1. Overall smooth and notched strength distributions for each of the four melting processes developed reasonably normal-appearing histogram plots with the exception of that for air melt-double VAR, which was skewed to the left.

2. Similarly, the overall distributions for the notched/smooth ultimate strength ratio developed normal-appearing histograms with the exception, again, of that for air melt-double VAR material which was skewed to the left.

3. A comparison of the distributions developed for the ductility data of each melting process showed that only the vacuum induction melt-VAR histogram developed a normal-appearing plot, while those for the remaining three processes were all skewed to the left.

The following conclusions were derived from interpretation of Appendix VI control charts depicting mean and range values for tensile properties at each billet section:

1. In all but a few instances, out-of-control mean values occurred in data developed from the top and bottom portions of the billets, while range values, as a rule, remained within three-sigma control limits.

2. Strength values generally tended to decrease from top to bottom end of the billet while ductility generally assumed the inverse tendency in keeping with the normal strength-ductility relationship.

3. Repeated instances in which eight or more consecutive points fall on the same side of the billet mean strongly indicate the introduction of a significant change in the manufacturing process variables, since the probability of this occurring by chance alone is 0.0039, or only four times in a thousand.

The following conclusions were derived from a comparison of melt process cost versus product uniformity in terms of the coefficient of variation for smooth specimen ultimate strength and for per cent reduction in area:

1. Generally, as quality is improved cost increases.

2. The air melt-double VAR processed-billet provides an obvious exception to the cost-quality relationship demonstrated by the other three process variations.

3. The air melt-double VAR material exhibits a quality level lower than that of either air melt-VAR or air melt-vacuum degas-VAR material, although the cost is approximately twice that of the latter two processes.

4. A substantial improvement in quality (decrease in coefficient of variation) for a relatively small increase in cost is indicated by comparison of the values for the air melt-VAR process and the conventional air melt process (derived from Phase II data).

5. The vacuum induction melt-VAR process delivers the highest quality product at the highest cost.

Since the coefficient of variation ($\frac{\sigma}{\bar{X}}$) value incorporates the average property value with its corresponding standard deviation, the coefficient was judged to be an acceptable measure of both uniformity and quality and was plotted against the per-pound cost of each of the four differently-processed vacuum arc remelt

billets and the conventionally-air melted Phase II material. Thus, the direct relationship between material cost and material quality as measured by tensile strength and ductility could be graphically portrayed. Process costs shown in Figure 27 are those incurred by the Contractor. The purchase of larger quantities of material (3500-pound billets were ordered in Phase III) should result in somewhat lower process costs.

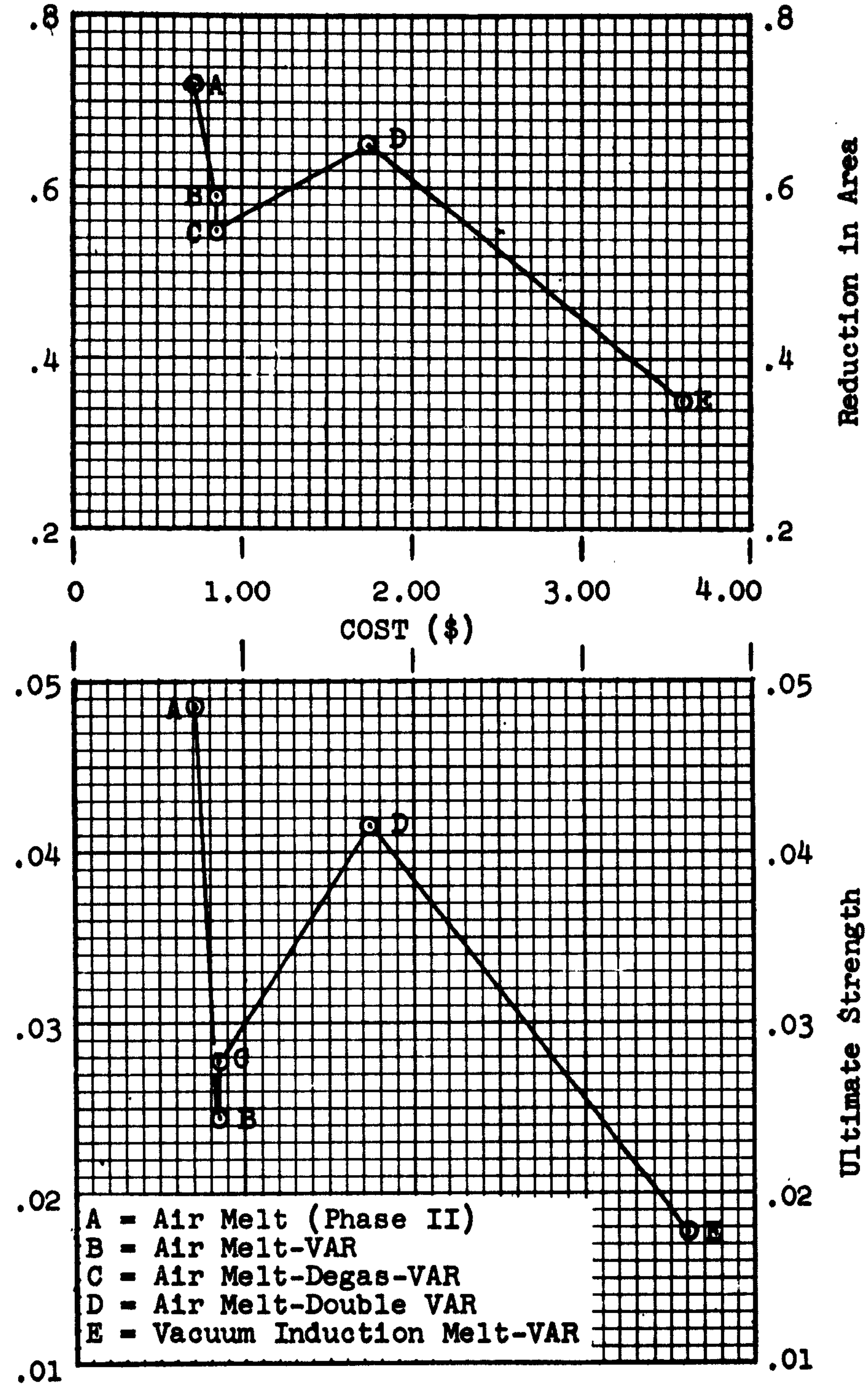


FIGURE 27

COEFFICIENT OF VARIATION FOR STRENGTH AND DUCTILITY VERSUS MELT PROCESS COST

VI. RECOMMENDATIONS

1. Continuation of the program as outlined for Phase IV in Supplemental Agreement No. 1 dated October 19, 1960 is strongly recommended. The demonstrated usefulness of data and statistical techniques for evaluating voluminous quantities of metallurgical data developed under Contract AF33-(600)-38767 make it highly desirable to verify and evaluate the information developed to date in closed-die, aircraft-quality, production forgings of high-strength steel. Phase IV has been pre-planned to effectively utilize the information developed in the first three phases in order to achieve the program aim of reduced weight and increased functional effectiveness in forged aerospace components.

2. The use of vacuum induction melt-vacuum arc remelt processed high-strength steel is recommended in instances where design considerations demand maximum ductility and uniformity to the extent that such requirements outweigh economic considerations imposed by the cost of material.

APPENDIX I

TENSILE PROPERTIES OF AIR MELT-VACUUM ARC REMELT H-11 STEEL (HEAT NO. W-24341-1)

SECTION 1

TRANSVERSE TENSILE PROPERTIES OF AIR MELT-VACUUM ARC REMELT H-11 STEEL (HEAT NO. W-24341-1)

TRANSVERSE TENSILE PROPERTIES
OF AIR MELT-VACUUM ARC REMELT
H 11 STEEL HEAT NO. W 24341-1

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
A	02 4	S	235.3	301.3	3.5	7.3	555
A	03 4	S	249.0	313.8	3.0	6.2	555
A	04 4	S	245.0	299.9	2.5	3.6	555
A	06 4	S	237.5	301.3	3.5	7.3	555
A	07 4	S	232.3	295.0	5.5	10.0	555
A	08 4	S	240.7	299.5	4.5	10.1	555
A	09 4	S	232.8	285.2	6.0	10.4	555
A	10 4	S	228.9	289.2	4.0	6.6	555
A	11 4	S	229.8	290.7	2.5	5.1	555
A	22 4	M	249.0	302.4	2.0	5.1	555
A	23 4	M					555
A	24 4	M	238.5	301.3	2.2	2.7	545
A	25 4	M	243.3	314.8	2.5	5.0	555
A	28 4	M	234.7	285.7	1.5	2.0	555
A	29 4	M	235.0	305.8	2.5	4.4	555
A	30 4	M	244.5	305.0	1.0	2.3	555
A	31 4	M	244.6	299.5	1.5	4.7	555
A	32 4	M	244.1	308.1	3.5	4.0	532
A	33 4	M	232.0	290.0	2.0	5.0	555
A	34 4	M	245.1	311.0	3.5	6.7	555
A	35 4	M	229.8	289.0	2.3	4.7	555
A	36 4	M	229.5	295.0	3.8	5.4	555
A	37 4	M	233.1	294.1	2.5	3.6	555
A	61 4	C					555
A	63 4	C	232.0	283.8	2.0	1.1	555
B	02 4	S	234.7	293.2	6.0	11.9	555
B	03 4	S	233.6	290.0	2.5	3.6	555
B	04 4	S	237.0	299.0	5.0	6.6	555
B	06 4	S	237.6	303.5	5.0	7.4	555
B	07 4	S	228.0	292.5	4.0	6.2	555
B	08 4	S	241.5	300.6	4.5	9.0	555
B	09 4	S	228.9	284.8	3.0	5.6	555
B	10 4	S	226.8	260.0	.8	2.3	555
B	11 4	S	235.8	290.0	2.0	3.9	555
B	22 4	M	239.1	298.9	4.0	7.8	555
B	23 4	M	241.2	303.0	1.5	3.1	555
B	24 4	M	237.0	271.3	1.0	2.7	545
B	25 4	M	243.9	302.9	1.5	4.4	555
B	28 4	M	231.0	292.5	2.5	3.1	555
B	29 4	M	242.3	304.5	1.5	2.4	555
B	30 4	M	237.0	298.8	2.0	3.5	555
B	31 4	M					555
B	32 4	M	238.0	296.9	1.5	1.2	532
B	33 4	M	230.5	288.5	2.0	3.1	555
B	34 4	M	240.0	302.8	3.5	8.2	555
B	35 4	M	237.0	264.8	.5	1.6	555
B	36 4	M	231.1	292.9	4.0	8.9	555
B	37 4	M	232.8	300.9	3.0	2.8	555
B	61 4	C	233.0	291.5	2.0	3.1	555
B	63 4	C	231.0	284.5	1.5	2.7	555
C	02 4	S	234.1	291.9	4.0	15.3	555
C	03 4	S	237.5	276.8		.4	555
C	04 4	S	233.5	292.0	3.0	3.9	555
C	06 4	S	234.1	294.4	2.5	3.2	555
C	07 4	S	227.8	287.5	5.5	9.6	555
C	08 4	S	241.5	298.2	4.5	7.4	555
C	09 4	S	232.6	289.0	4.0	6.3	555
C	10 4	S	233.2	294.9	3.5	5.9	555
C	11 4	S	234.3	300.0	7.0	14.1	555
C	22 4	M	240.1	292.8	2.0	2.8	555
C	23 4	M	236.6	285.7	1.5	2.4	555
C	24 4	M	229.5	290.0	2.5	4.7	545
C	25 4	M	237.5	293.9	2.0	1.9	555
C	28 4	M	231.5	299.4	4.0	6.3	555
C	29 4	M	236.5	291.3	1.5	2.2	555
C	30 4	M	233.8	302.5	3.0	3.1	555
C	31 4	M	234.1	302.1	3.0	6.7	555
C	32 4	M	239.8	292.0	5.0	10.1	532
C	33 4	M	234.1	291.1	2.5	2.8	555
C	34 4	M	240.5	312.5	4.0	8.9	555
C	35 4	M	224.3	286.5	1.8	1.4	555
C	36 4	M	232.3	295.0	4.5	9.2	555

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
C	37 4	M	222.5	287.3	2.0	3.1	555
C	61 4	C	233.9	285.7	1.5	1.7	555
C	63 4	C	222.5	276.5	1.5	3.9	555
D	02 4	S	236.6	295.0	5.0	11.9	555
D	03 4	S	235.5	293.8	2.5	5.8	555
D	04 4	S	236.0	290.8	1.5	1.9	555
D	06 4	S	234.1	289.7	5.5	11.5	555
D	07 4	S	228.5	292.5	2.5	4.3	555
D	08 4	S	234.8	298.8	3.3	5.4	555
D	09 4	S	228.5	287.2	5.5	11.2	555
D	10 4	S	236.3	294.9	6.0	14.6	555
D	11 4	S	239.8	296.3	7.0	18.1	555
D	22 4	M	247.1	302.8	2.5	6.3	555
D	23 4	M	235.5	289.3	1.5	2.8	555
D	24 4	M	232.0	292.5	2.2	5.0	545
D	25 4	M	237.0	310.0	3.5	4.7	555
D	28 4	M	235.0	295.8	4.5	5.5	555
D	29 4	M					555
D	30 4	M	236.0	300.0	2.5	3.5	555
D	31 4	M	242.0	306.5	3.0	6.7	555
D	32 4	M	242.3	295.2	1.5	2.4	532
D	33 4	M	225.0	283.5	2.5	2.7	555
D	34 4	M	239.8	298.9	2.0	3.2	555
D	35 4	M	224.5	281.8	2.0	4.3	555
D	36 4	M	229.5	291.3	5.0	10.0	555
D	37 4	M	225.5	286.4	2.0	4.3	555
D	61 4	C	226.5	275.3	1.5	2.7	555
D	63 4	C	225.5	286.0	2.5	3.1	555
E	02 4	S	236.1	292.8	7.0	16.0	555
E	03 4	S	236.6	298.5	5.0	11.2	555
E	04 4	S	233.0	291.5	4.0	1.9	555
E	06 4	S	238.2	299.5	4.5	8.2	555
E	07 4	S	231.3	293.8	5.5	8.9	555
E	08 4	S	236.2	289.5	1.5	2.6	555
E	09 4	S	231.6	289.4	6.5	11.2	555
E	10 4	S	232.5	291.8	5.0	9.6	555
E	11 4	S	238.0	300.0	7.5	17.0	555
E	22 4	M	241.5	299.0	4.5	7.0	555
E	23 4	M	237.3	290.0	1.5	3.6	555
E	24 4	M	230.6	292.2	3.0	5.8	545
E	25 4	M	239.0	306.3	3.5	7.7	555
E	28 4	M	230.6	297.1	3.0	5.1	555
E	29 4	M	233.1	295.0	1.8	2.6	555
E	30 4	M	235.0	305.0	3.5	4.7	555
E	31 4	M	235.0	300.2	4.0	8.2	555
E	32 4	M	234.0	298.8	4.0	7.7	532
E	33 4	M	229.5	279.0	1.0	.8	555
E	34 4	M	234.2	298.6	2.5	4.7	555
E	35 4	M	231.8	283.5	1.5	2.4	555
E	36 4	M	230.0	293.8	5.5	10.0	555
E	37 4	M	222.5	287.3	2.0	5.9	555
E	61 4	C	225.0	282.0	1.5	2.7	555
E	63 4	C	226.5	285.8	2.5	1.9	555
H	02 4	S	238.2	296.9	6.0	13.6	555
H	03 4	S	237.0	294.1	4.0	10.4	555
H	04 4	S	233.0	293.2	6.0	8.6	555
H	06 4	S	235.7	300.9	5.5	13.1	555
H	07 4	S	230.0	290.0	2.0	3.9	555
H	08 4	S	238.5	296.3	4.0	7.8	555
H	09 4	S	229.5	278.5	2.0	3.9	555
H	10 4	S	225.8	287.5	4.0	6.6	555
H	11 4	S	232.8	300.0	3.5	5.0	555
H	22 4	M	236.5	297.3	3.5	6.6	555
H	23 4	M	233.2	290.9	1.0	1.0	555
H	24 4	M	232.5	295.0	5.0	8.9	545
H	25 4	M	239.6	312.1	3.5	6.6	555
H	28 4	M	236.1	295.8	2.5	7.8	555
H	29 4	M	228.3	288.3	2.0	3.2	555
H	30 4	M	229.3	295.0	2.5	5.0	555
H	31 4	M	238.1	310.8	4.0	6.3	555
H	32 4	M	233.6	297.0	4.5	8.9	532
H	33 4	M	232.5	292.3	4.0	5.4	555
H	34 4	M	236.1	300.8	4.5	13.4	555
H	35 4	M	225.5	288.8	4.0	7.0	555
H	36 4	M	229.0	293.8	3.5	5.0	555

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
H	37 4	M	225.5	289.6	2.5	4.4	555
H	61 4	C	226.5	286.3	3.0	4.4	555
H	63 4	C	228.3	285.0	1.7	3.9	555
I	02 4	S	234.4	296.2	3.5	9.6	555
I	03 4	S	235.6	297.8	6.5	14.5	555
I	04 4	S	232.5	293.8	4.0	9.6	555
I	06 4	S	235.3	299.5	3.5	4.0	555
I	07 4	S	227.3	287.5	2.5	4.3	555
I	08 4	S	237.8	297.5	6.3	13.3	555
I	09 4	S	230.5	290.9	5.0	9.3	555
I	10 4	S	226.2	285.0	5.0	9.3	555
I	11 4	S	232.5	297.5	5.5	5.8	555
I	22 4	M	239.0	299.0	3.5	2.3	555
I	23 4	M	237.5	288.0	1.5	2.8	555
I	24 4	M	230.0	296.3	2.5	3.9	545
I	25 4	M	239.1	287.0	1.0	5.5	555
I	28 4	M	235.1	294.4	2.0	2.4	555
I	29 4	M	228.3	291.0	1.8	3.4	555
I	30 4	M	236.4	302.0	3.0	5.9	555
I	31 4	M	240.5	309.5	3.0	7.4	555
I	32 4	M	231.0	297.0	5.0	10.1	532
I	33 4	M	228.1	291.1	2.7	5.7	563
I	34 4	M	236.0	298.5	3.5	6.3	555
I	35 4	M	222.8	283.8	2.0	4.7	555
I	36 4	M	232.8	290.9	4.0	4.4	555
I	37 4	M	224.0	282.5	2.0	2.4	555
I	61 4	C	224.0	285.1	2.5	3.6	555
I	63 4	C	228.8	285.6	1.7	3.6	555
J	02 4	S	234.3	293.7	3.5	5.1	555
J	03 4	S	229.5	290.0	4.5	8.9	555
J	04 4	S	235.0	293.8	4.0	11.9	555
J	06 4	S	234.9	298.3	5.0	10.5	555
J	07 4	S	225.3	277.5	5.0	9.6	555
J	08 4	S	239.1	298.0	3.0	3.6	555
J	09 4	S	230.6	288.2	6.5	14.2	555
J	10 4	S	233.8	283.2	1.5	3.2	555
J	11 4	S	233.0	280.0	1.0	1.9	555
J	22 4	M	239.0	298.3	4.5	9.6	555
J	23 4	M	237.0	290.8	1.5	2.3	555
J	24 4	M	227.3	292.2	2.2	4.7	545
J	25 4	M	236.6	297.9	3.5	7.4	555
J	28 4	M	232.0	288.8	4.0	7.4	555
J	29 4	M	230.8	294.8	2.5	2.6	555
J	30 4	M	232.3	301.0	4.0	5.1	555
J	31 4	M	238.1	302.8	3.5	5.9	555
J	32 4	M	234.2	299.1	4.5	4.7	532
J	33 4	M	227.0	287.2	2.7	5.1	563
J	34 4	M	237.3	302.5	4.0	6.2	555
J	35 4	M	226.8	286.5	2.3	3.9	555
J	36 4	M	227.0	286.5	4.0	11.1	555
J	37 4	M	226.0	291.0	3.0	5.0	555
J	61 4	C	239.5	296.5	1.5	2.4	555
J	63 4	C	226.5	284.3	2.0	4.3	555
K	02 4	S	233.0	291.4	6.5	10.5	555
K	03 4	S	232.0	292.0	3.0	3.5	555
K	04 4	S	231.5	295.5	3.5	9.2	555
K	06 4	S	239.2	297.0	5.0	9.0	555
K	07 4	S	229.3	288.8	5.0	8.1	555
K	08 4	S	232.5	292.0	5.0	10.8	555
K	09 4	S	228.1	288.4	4.5	7.4	534
K	10 4	S	229.7	289.2	4.0	8.8	563
K	11 4	S	230.5	295.0	5.5	11.1	555
K	22 4	M	238.2	294.2	4.0	11.2	534
K	23 4	M	233.3	291.9	2.5	4.7	534
K	24 4	M	228.3	293.8	4.0	6.6	563
K	25 4	M	230.5	296.9	3.5	7.0	534
K	28 4	M	227.6	292.1	2.0	4.0	555
K	29 4	M	231.3	292.0	2.0	3.2	555
K	30 4	M	226.5	270.0	1.0	2.3	555
K	31 4	M	233.0	293.5	2.0	4.7	555
K	32 4	M	231.9	294.2	3.5	6.3	532
K	33 4	M	230.6	286.3	2.5	5.1	555
K	34 4	M	233.0	298.8	3.0	4.7	534
K	35 4	M	227.5	284.0	2.5	3.8	555
K	36 4	M	231.5	292.5	4.5	9.7	555

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI 2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
K	37 4	M	219.5	284.0	3.0	3.1	555
K	61 4	C	224.5	285.8	3.0	6.2	555
K	63 4	C	225.0	283.0	3.0	3.5	555
L	02 4	S	237.6	299.0	5.0	10.2	555
L	03 4	S	230.0	291.8	4.0	6.2	555
L	04 4	S	231.0	293.8	4.0	6.6	555
L	06 4	S	233.9	294.5	5.0	8.2	555
L	07 4	S	225.0	288.8	4.0	7.0	555
L	08 4	S	236.2	292.0	4.0	9.3	555
L	09 4	S	232.0	290.3	4.5	8.5	534
L	10 4	S	230.0	291.1	6.5	13.8	563
L	11 4	S	232.5	295.0	5.5	11.5	555
L	22 4	M	240.1	297.9	3.5	11.6	534
L	23 4	M	236.5	289.6	1.8	4.4	534
L	24 4	M	230.8	292.2	4.0	7.7	563
L	25 4	M					534
L	28 4	M	228.9	299.4	3.0	7.0	555
L	29 4	M	228.5	289.8	2.3	4.7	555
L	30 4	M	231.2	298.3	3.5	6.7	555
L	31 4	M	235.5	299.7	2.5	5.5	555
L	32 4	M	231.7	297.0	4.5	6.7	532
L	33 4	M	228.3	284.5	2.0	4.3	555
L	34 4	M	236.7	298.8	2.0	4.6	534
L	35 4	M	225.3	286.0	2.5	3.9	555
L	36 4	M	223.0	287.5	3.5	5.4	555
L	37 4	M	222.1	286.1	2.5	2.4	555
L	61 4	C	224.1	281.2	3.0	3.6	555
L	63 4	C	225.0	285.0	2.5	3.9	555
M	02 4	S	231.5	294.1	5.5	8.6	555
M	03 4	S	230.0	293.8	4.0	8.9	555
M	04 4	S	234.9	293.2	3.0	5.9	555
M	06 4	S	224.2	294.4	2.5	5.5	555
M	07 4	S	227.8	291.3	5.0	7.0	555
M	08 4	S	231.5	293.5	7.0	16.0	555
M	09 4	S	229.6	289.6	5.0	10.4	534
M	10 4	S	226.5	288.0	5.5	11.1	563
M	11 4	S	232.5	291.3	2.5	6.6	555
M	22 4	M	238.1	296.4	3.5	3.6	534
M	23 4	M	229.8	282.8	1.0	1.4	534
M	24 4	M	229.0	287.5	2.0	3.1	563
M	25 4	M	233.5	298.2	3.0	4.0	534
M	28 4	M	228.6	292.0	4.0	6.3	555
M	29 4	M	225.6	292.8	2.8	3.4	555
M	30 4	M	231.6	297.0	2.5	2.8	555
M	31 4	M	235.5	297.2	3.0	3.6	555
M	32 4	M	232.2	292.0	4.0	5.1	532
M	33 4	M	223.3	284.2	2.7	2.8	555
M	34 4	M	236.8	302.5	3.8	6.6	534
M	35 4	M	221.5	283.8	3.0	4.3	555
M	36 4	M	224.5	280.0	3.5	7.3	555
M	37 4	M	217.5	287.3	2.5	3.5	555
M	61 4	C	224.0	285.0	3.5	6.7	555
M	63 4	C	224.1	284.2	4.0	6.7	555
N	02 4	S	247.4	296.0	4.5	14.1	555
N	03 4	S	231.0	294.5	3.0	7.3	555
N	04 4	S	232.0	293.1	2.5	6.7	555
N	06 4	S	234.3	297.0	5.5	13.1	555
N	07 4	S	223.5	288.8	5.2	7.0	555
N	08 4	S	232.0	292.5	5.0	8.2	555
N	09 4	S	230.0	289.5	5.5	9.2	534
N	10 4	S	229.8	289.4	6.5	11.9	563
N	11 4	S	232.0	293.8	4.5	7.7	555
N	22 4	M	235.9	292.2	4.5	6.7	534
N	23 4	M	234.9	290.7	2.5	5.5	534
N	24 4	M	228.5	283.8	2.5	4.7	563
N	25 4	M	234.4	294.5	3.5	9.7	534
N	28 4	M	223.0	293.2	4.5	7.8	555
N	29 4	M	227.3	285.3	1.3	2.6	555
N	30 4	M	229.0	290.0	2.5	3.5	555
N	31 4	M	240.5	300.7	2.5	5.1	555
N	32 4	M	234.3	296.9	3.5	6.3	532
N	33 4	M	225.8	283.8	2.0	3.1	555
N	34 4	M	235.8	301.0	3.5	5.0	534
N	35 4	M	223.5	285.9	2.3	3.2	555
N	36 4	M	224.3	288.8	2.5	5.4	555

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
N	37 4	M	220.5	282.3	2.5	2.7	555
N	61 4	C	223.0	278.8	2.0	2.0	555
N	63 4	C	223.8	281.5	2.5	3.5	555
P	02 4	S	234.3	292.5	6.0	13.7	555
P	03 4	S	228.5	291.0	6.5	10.7	555
P	04 4	S	234.5	295.8	5.0	10.0	555
P	06 4	S	232.5	298.2	5.5	9.0	555
P	07 4	S	223.5	285.0	5.0	6.6	555
P	08 4	S	234.2	293.5	3.8	6.3	555
P	09 4	S	225.0	284.8	6.0	12.7	534
P	10 4	S	232.7	291.9	4.5	8.7	563
P	11 4	S	233.0	300.0	5.0	9.2	555
P	22 4	M	240.0	296.5	2.5	3.1	534
P	23 4	M	234.4	290.0	2.3	4.5	534
P	24 4	M	224.3	291.3	4.2	6.2	563
P	25 4	M	230.1	295.3	4.0	3.2	534
P	28 4	M	227.5	292.0	4.5	5.1	555
P	29 4	M	224.0	288.8	2.5	3.9	555
P	30 4	M	227.8	292.5	2.5	3.9	555
P	31 4	M	231.5	296.5	4.0	7.3	555
P	32 4	M	233.1	295.8	4.5	9.7	532
P	33 4	M	227.1	286.7	2.0	3.6	555
P	34 4	M	234.1	300.5	4.3	6.3	534
P	35 4	M	225.0	285.0	2.8	3.1	555
P	36 4	M	229.2	289.0	4.0	6.7	555
P	37 4	M	224.5	288.8	2.5	5.4	555
P	61 4	C	221.5	2[illegible]4.0	3.5	7.0	555
P	63 4	C	218.9	273.4	4.5	7.1	555
S	02 4	S	236.5	291.9	5.0	13.5	555
S	03 4	S	232.5	292.0	5.5	9.6	555
S	04 4	S	232.5	293.4	5.0	12.7	555
S	06 4	S	230.8	297.5	4.0	7.0	555
S	07 4	S	226.3	287.5	6.0	10.7	555
S	08 4	S	230.0	288.8	5.5	11.2	555
S	09 4	S	227.1	289.5	6.0	11.6	534
S	10 4	S	228.1	290.0	6.0	13.1	563
S	11 4	S	230.0	295.0	7.0	15.9	555
S	22 4	M	235.0	294.0	3.0	3.1	534
S	23 4	M	232.2	289.2	1.8	4.3	534
S	24 4	M	226.5	290.0	4.5	7.7	563
S	25 4	M	235.0	299.5	3.5	7.8	534
S	28 4	M	227.5	295.8	4.0	7.4	555
S	29 4	M	227.5	291.0	2.0	3.0	555
S	30 4	M	232.5	296.0	3.0	6.6	555
S	31 4	M	231.0	294.3	4.5	7.5	555
S	32 4	M	233.0	294.6	4.5	10.6	532
S	33 4	M	224.4	286.8	2.5	5.2	555
S	34 4	M	236.9	301.5	4.0	5.3	534
S	35 4	M	224.5	273.3	1.5	2.3	555
S	36 4	M	222.0	287.5	4.2	7.7	555
S	37 4	M	224.5	282.8	2.0	3.5	555
S	61 4	C	222.0	282.3	3.0	3.5	555
S	63 4	C	225.0	285.0	3.0	3.9	555
T	02 4	S	231.9	289.8	5.5	14.6	555
T	03 4	S	228.1	289.9	5.0	13.4	555
T	04 4	S	232.5	293.5	4.5	6.6	555
T	06 4	S	232.8	297.0	5.5	10.1	555
T	07 4	S	226.8	287.5	6.2	12.2	555
T	08 4	S	233.9	292.0	5.8	13.7	555
T	09 4	S	230.0	287.8	6.5	14.8	534
T	10 4	S	229.3	287.8	5.0	10.2	563
T	11 4	S	228.5	290.0	6.5	14.8	555
T	22 4	M	236.1	296.1	5.0	6.7	534
T	23 4	M	233.2	290.3	3.3	5.9	534
T	24 4	M	222.2	288.2	3.7	5.0	563
T	25 4	M	235.1	296.2	4.5	12.7	534
T	28 4	M	225.1	293.2	3.5	7.8	555
T	29 4	M	231.2	293.0	3.0	4.8	555
T	30 4	M	231.0	295.8	4.0	5.1	555
T	31 4	M	236.5	299.5	3.5	4.7	555
T	32 4	M	233.5	293.2	2.5	5.9	532
T	33 4	M	228.9	289.3	3.0	4.0	555
T	34 4	M	233.5	293.5	4.5	10.5	534
T	35 4	M	222.5	287.0	2.0	2.3	555
T	36 4	M	225.0	286.3	5.0	9.2	555

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
T	37 4	M	221.5	285.0	2.0	4.7	555
T	61 4	C					534
T	63 4	C	223.0	280.0	2.0	4.7	555
V	02 4	S	237.0	292.5	5.0	10.2	555
V	03 4	S	225.7	288.8	7.0	14.2	555
V	04 4	S	230.0	294.0	5.0	11.5	555
V	06 4	S	233.9	299.6	6.5	15.7	555
V	07 4	S	223.5	287.5	5.0	7.7	555
V	08 4	S	233.2	288.1	5.5	13.3	555
V	09 4	S	227.7	285.8	5.5	10.1	534
V	10 4	S	228.4	288.2	3.5	4.4	563
V	11 4	S	226.5	267.5	1.0	1.9	555
V	22 4	M	236.6	293.2	4.5	11.6	534
V	23 4	M	227.0	289.0	2.8	3.4	534
V	24 4	M	225.8	286.3	2.5	3.9	563
V	25 4	M	233.5	297.9	2.5	6.3	534
V	28 4	M	226.6	294.5	4.5	5.1	555
V	29 4	M	225.3	290.5	3.0	3.9	555
V	30 4	M	226.0	291.2	3.5	6.6	555
V	31 4	M	232.1	296.0	4.5	9.7	555
V	32 4	M	236.1	294.5	4.0	7.4	532
V	33 4	M	224.8	285.9	3.0	4.7	555
V	34 4	M	233.0	297.5	4.8	7.7	534
V	35 4	M	220.0	277.5	2.0	4.7	555
V	36 4	M	228.6	287.4	5.0	11.6	555
V	37 4	M	224.0	290.3	3.5	6.6	555
V	61 4	C	223.1	284.4	3.0	5.9	555
V	63 4	C	227.5	285.5	3.0	5.4	555

SECTION 2

LONGITUDINAL TENSILE PROPERTIES OF AIR MELT-VACUUM ARC REMELT H-11 STEEL (HEAT NO. W-24341-1)

LONGITUDINAL TENSILE PROPERTIES
OF AIR MELT-VACUUM ARC REMELT
H 11 STEEL HEAT NO. W 24341-1

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
A	14 5	S	240.0	305.0	6.0	11.5	578
A	15 5	S	241.5	300.5	7.8	23.1	555
A	16 5	S	246.5	312.5	8.0	15.6	555
A	18 5	S	247.3	311.3	5.7	21.3	563
A	41 5	M	230.5	295.0	4.0	6.6	555
A	42 5	M	236.5	305.0	4.0	8.1	555
A	43 5	M	233.8	300.0	4.2	6.6	555
A	45 5	M	242.0	303.4	3.0	4.3	555
A	46 5	M	237.0	301.3	3.2	5.8	555
A	47 5	M					601
A	49 5	M	241.0	302.2	1.5	4.4	578
A	50 5	M	244.0	310.8	4.0	6.3	555
A	51 5	M	227.5	298.8	3.3	3.9	555
A	65 5	C	238.0	305.0	2.5	3.9	578
A	67 5	C	239.3	307.5	3.5	5.4	578
B	14 5	S	239.5	307.5	6.0	12.3	578
B	15 5	S	241.3	298.2	4.8	9.0	555
B	16 5	S	239.0	307.5	4.5	7.0	555
B	18 5	S	240.3	307.5	6.0	13.0	563
B	41 5	M	232.2	305.8	3.0	5.1	555
B	42 5	M	226.0	290.0	4.5	6.6	555
B	43 5	M	235.5	301.3	4.5	7.0	555
B	45 5	M	239.1	307.1	4.0	10.4	555
B	46 5	M	229.5	295.0	6.0	12.2	555
B	47 5	M	240.6	307.0	2.0	3.6	601
B	49 5	M	245.0	310.0	3.0	3.5	578
B	50 5	M					555
B	51 5	M	235.0	305.0	3.0	5.0	555
B	65 5	C	235.8	310.0	4.0	5.0	578
C	14 5	S	234.5	291.0	4.5	8.9	578
C	15 5	S	237.0	303.0	8.0	21.3	555
C	16 5	S	233.8	298.9	6.5	15.6	555
C	18 5	S	240.8	303.8	4.2	9.6	563
C	41 5	M	227.8	293.2	4.5	10.4	555
C	42 5	M	228.5	289.5	5.5	12.6	555
C	43 5	M	222.0	287.5	4.2	7.0	555
C	45 5	M	231.0	291.8	2.0	7.7	555
C	46 5	M	230.5	290.0	4.2	7.0	555
C	47 5	M	230.8	301.3	4.0	7.3	601
C	49 5	M	241.5	303.8	2.5	5.8	578
C	50 5	M	232.5	305.0	4.5	7.3	555
C	51 5	M	225.5	292.0	5.0	7.0	555
C	65 5	C	237.5	303.8	2.5	11.1	578
C	67 5	C	232.0	296.3	4.5	8.5	578
D	14 5	S	238.1	301.6	9.0	16.7	578
D	15 5	S	234.0	301.8	8.5	21.2	555
D	16 5	S	233.8	298.0	7.0	16.7	555
D	18 5	S	237.4	308.7	8.0	27.9	555
D	41 5	M	222.8	292.5	3.5	5.4	555
D	42 5	M	229.0	292.0	5.0	11.1	555
D	43 5	M	227.5	287.5	2.8	5.4	555
D	45 5	M	230.1	289.8	4.5	5.5	555
D	46 5	M	230.0	288.8	5.0	10.7	555
D	47 5	M	233.0	303.8	3.5	7.0	601
D	49 5	M	236.5	303.0	2.0	2.7	578
D	50 5	M	231.3	305.0	5.0	10.4	555
D	51 5	M	222.8	292.8	3.5	4.7	555
D	65 5	C	225.0	300.0	3.5	5.8	578
D	67 5	C	234.3	300.0	3.5	5.0	578
E	14 5	S	238.1	301.6	6.5	19.6	578
E	15 5	S	239.5	299.5	8.3	23.0	555
E	16 5	S	237.0	299.5	7.5	16.6	555
E	18 5	S	237.5	307.5	5.0	8.1	555
E	41 5	M	227.3	297.5	4.0	7.3	555
E	42 5	M	232.5	294.8	5.0	12.6	555
E	43 5	M	227.3	292.5	4.0	5.0	555
E	45 5	M	230.5	291.0	4.0	5.4	555
E	46 5	M	228.0	290.0	3.2	8.1	555
E	47 5	M	229.0	300.0	3.5	6.2	601

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
E	49 5	M	236.5	303.8	2.8	3.9	578
E	50 5	M	232.1	298.1	7.0	18.5	555
E	51 5	M	225.8	296.5	3.3	4.3	555
E	65 5	C	228.0	297.5	5.0	8.9	578
E	67 5	C	234.5	295.0	3.0	5.5	578
H	14 5	S		302.8	8.2	20.4	578
H	15 5	S	236.0	299.9	6.5	16.8	555
H	16 5	S	236.7	299.9	8.5	31.2	555
H	18 5	S	234.7	298.5	8.0	28.6	555
H	41 5	M	232.5	290.8	4.0	9.2	555
H	42 5	M	232.5	293.0	3.5	14.8	555
H	43 5	M	226.5	291.0	4.0	8.5	555
H	45 5	M	232.1	290.2	2.0	5.9	555
H	46 5	M	229.5	289.8	5.5	15.6	555
H	47 5	M	233.3	298.9	3.0	7.9	578
H	49 5	M	210.0	274.5	3.5	15.6	578
H	50 5	M	215.0	277.0	4.0	17.4	555
H	51 5	M	232.8	297.1	4.0	7.5	555
H	65 5	C	228.1	296.3	4.0	6.7	555
H	67 5	C	228.5	295.0	4.2	8.3	578
I	14 5	S	234.0	300.5	6.0	10.5	578
I	15 5	S	236.8	297.5	7.5	20.9	555
I	16 5	S	236.8	299.5	6.5	16.8	555
I	18 5	S	240.5	300.4	7.0	11.6	555
I	41 5	M	227.5	285.0	4.0	6.2	555
I	42 5	M	229.5	289.3	7.5	16.6	555
I	43 5	M	226.0	291.3	4.8	6.6	555
I	45 5	M	227.5	289.5	4.0	8.5	555
I	46 5	M	224.8	285.8	6.5	13.1	555
I	47 5	M	226.7	287.2	2.5	3.2	601
I	49 5	M	238.1	299.0	4.0	7.8	578
I	50 5	M	234.5	297.5	6.0	11.1	555
I	51 5	M	225.0	291.5	4.8	6.6	555
I	65 5	C	225.8	300.0	5.0	8.9	578
I	67 5	C	230.0	292.5	5.0	10.7	578
J	14 5	S	237.3	298.5	8.0	21.7	578
J	15 5	S	233.5	295.9	7.3	16.7	555
J	16 5	S	235.0	305.0	7.0	16.3	555
J	18 5	S	243.0	295.5	6.5	18.6	555
J	41 5	M	227.8	297.5	4.5	7.3	555
J	42 5	M	231.8	292.9	4.5	10.4	555
J	43 5	M	227.0	291.3	5.8	9.2	555
J	45 5	M	229.9	287.9	4.0	7.4	555
J	46 5	M	226.8	290.0	7.8	17.7	555
J	47 5	M	230.0	302.5	3.5	7.7	601
J	49 5	M	235.0	302.5	5.3	12.2	578
J	50 5	M	233.8	300.8	6.5	12.2	555
J	51 5	M	221.8	290.0	4.8	9.2	555
J	65 5	C	229.0	300.0	5.0	5.8	578
J	67 5	C	230.0	290.0	3.0	4.7	578
K	14 5	S	233.7	296.5	5.5	16.3	555
K	15 5	S	235.7	300.8	6.0	12.3	578
K	16 5	S	231.0	299.5	7.5	19.2	555
K	18 5	S	237.5	297.5	7.0	19.5	555
K	41 5	M	226.8	291.3	5.8	8.1	555
K	42 5	M	228.0	291.5	5.5	10.4	555
K	43 5	M	221.8	286.3	4.0	7.7	555
K	45 5	M	228.0	286.5	4.0	7.7	555
K	46 5	M	228.0	292.5	6.0	10.7	555
K	47 5	M	227.3	297.5	5.0	7.7	555
K	49 5	M	229.3	298.3	3.8	4.7	555
K	50 5	M	231.8	302.0	4.5	8.6	555
K	51 5	M	221.0	289.5	2.8	5.4	555
K	65 5	C	222.5	292.5	4.0	5.8	578
K	67 5	C	225.5	292.2	5.5	5.9	578
L	14 5	S	231.6	297.8	7.0	14.5	555
L	15 5	S	233.2	300.8	9.0	24.5	578
L	16 5	S	239.5	300.0	7.5	17.8	555
L	18 5	S	235.6	308.3	6.0	10.4	555
L	41 5	M	220.0	288.8	5.0	9.6	555
L	42 5	M	223.5	288.5	5.0	9.6	555
L	43 5	M	220.3	285.0	6.0	11.1	555
L	45 5	M	227.0	287.9	2.5	6.3	555

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
L	46 5	M	228.3	286.3	2.5	4.7	555
L	47 5	M	229.7	298.6	3.5	3.9	555
L	49 5	M	234.5	297.0	4.5	6.6	555
L	50 5	M	234.0	296.0	5.3	11.7	555
L	51 5	M	218.1	286.0	5.5	6.6	555
L	65 5	C	222.5	291.3	6.5	12.2	555
L	67 5	C	225.5	292.2	3.0	8.6	578
M	14 5	S	236.0	298.3	8.0	16.6	555
M	15 5	S	233.0	295.2	6.0	14.2	578
M	16 5	S	233.8	293.7	7.5	19.1	555
M	18 5	S	236.5	299.6	6.5	19.9	555
M	41 5	M	222.8	292.5	4.5	8.1	555
M	42 5	M	223.5	291.5	4.5	9.6	555
M	43 5	M	224.5	286.3	4.0	7.0	555
M	45 5	M	228.1	287.2	4.5	10.1	555
M	46 5	M	222.8	288.8	4.2	8.5	555
M	47 5	M	225.0	295.0	5.0	9.6	555
M	49 5	M	227.5	296.3	4.5	6.6	555
M	50 5	M	228.8	295.8	4.0	8.9	555
M	51 5	M	222.8	288.8	3.8	6.2	555
M	65 5	C	225.0	292.5	4.0	10.0	555
M	67 5	C	228.3	295.0	3.5	5.0	578
N	14 5	S	234.0	299.9	8.0	15.3	555
N	15 5	S	231.5	291.5	7.5	20.6	578
N	16 5	S	234.8	297.5	5.0	10.0	555
N	18 5	S	243.1	295.0	6.5	16.0	555
N	41 5	M	223.3	284.5	4.0	7.4	555
N	42 5	M	228.0	289.0	5.5	14.1	555
N	43 5	M	223.0	286.3	4.8	8.5	555
N	45 5	M	228.0	285.8	4.0	8.1	555
N	46 5	M	226.1	290.8	4.0	6.7	555
N	47 5	M	223.0	296.3	3.5	5.0	555
N	49 5	M	229.1	298.2	3.5	6.3	555
N	50 5	M	236.2	301.3	4.5	7.8	555
N	51 5	M	221.8	288.3	4.0	5.4	555
N	65 5	C	224.3	291.3	5.0	8.1	555
N	67 5	C	231.5	293.0	4.5	7.3	578
P	14 5	S	235.1	298.6	6.5	17.8	555
P	15 5	S	232.5	296.0	7.5	19.7	578
P	16 5	S	234.2	298.8	7.3	15.1	555
P	18 5	S	240.9	308.2	6.5	14.9	555
P	41 5	M	226.3	287.5	5.2	10.7	555
P	42 5	M	226.0	285.5	6.0	7.3	555
P	43 5	M	225.3	288.8	5.5	10.4	555
P	45 5	M	230.1	285.8	4.0	10.8	555
P	46 5	M	225.0	292.5	5.8	12.2	555
P	47 5	M	229.0	298.8	6.0	9.2	555
P	49 5	M	231.0	292.0	3.5	7.0	555
P	50 5	M	232.5	298.2	5.5	11.4	555
P	51 5	M	220.0	285.5	4.3	7.7	555
P	65 5	C	224.5	293.8	5.5	10.7	555
P	67 5	C	229.5	293.2	6.0	12.7	578
S	14 5	S	233.0	297.3	7.5	18.4	555
S	15 5	S	231.2	294.5	7.8	19.6	578
S	16 5	S	234.3	296.8	7.0	17.8	555
S	18 5	S	238.0	297.5	8.0	23.0	555
S	41 5	M	223.0	290.0	4.8	7.3	555
S	42 5	M	224.1	284.5	6.0	10.4	555
S	43 5	M	224.3	288.8	5.5	10.0	555
S	45 5	M	224.4	284.5	4.5	9.7	555
S	46 5	M	224.0	287.5	6.0	11.9	555
S	47 5	M	223.8	287.5	3.5	5.4	555
S	49 5	M	227.8	293.8	3.3	5.4	555
S	50 5	M	226.8	298.8	5.0	11.1	555
S	51 5	M	220.8	288.8	4.3	7.3	555
S	65 5	C	224.9	291.7	5.0	7.8	555
S	67 5	C	229.0	292.0	5.0	9.2	578
T	14 5	S	230.5	293.3	7.0	16.6	555
T	15 5	S	230.5	295.8	6.5	17.1	578
T	16 5	S	231.5	296.2	7.5	18.7	555
T	18 5	S	232.5	295.0	7.0	17.4	555
T	41 5	M	224.8	290.0	3.2	4.3	555
T	42 5	M	224.5	288.0	5.0	7.3	555

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI 2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
T	43 5	M	221.8	285.0	4.0	5.4	555
T	45 5	M	228.5	285.3	4.5	9.3	555
T	46 5	M	222.5	290.0	5.2	9.6	555
T	47 5	M	225.8	296.3	4.0	6.6	555
T	49 5	M	233.0	296.2	4.5	9.5	555
T	50 5	M	227.3	300.0	5.0	11.5	555
T	51 5	M	223.0	287.5	5.5	10.0	555
T	65 5	C	225.3	293.8	5.5	10.7	555
T	67 5	C	229.1	290.1	4.5	7.4	578
V	14 5	S	228.5	294.0	6.5	14.9	555
V	15 5	S		292.1	6.0	14.9	578
V	16 5	S	233.5	297.5	7.0	15.2	555
V	18 5	S	232.5	296.0	7.0	15.3	555
V	41 5	M	223.5	288.8	4.2	8.9	555
V	42 5	M	224.5	289.3	5.0	8.9	555
V	43 5	M	222.5	286.3	4.0	7.3	555
V	45 5	M	226.5	283.5	4.5	7.3	555
V	46 5	M	223.0	288.8	5.2	10.7	555
V	47 5	M	223.3	297.5	4.5	7.3	555
V	49 5	M	231.0	298.3	4.0	8.9	555
V	50 5	M	233.1	300.9	5.5	11.2	555
V	51 5	M	222.3	290.0	4.3	7.3	555
V	65 5	C	225.0	292.5	5.0	7.7	555
V	67 5	C	228.5	290.8	6.0	11.9	578

SECTION 3

TRANSVERSE NOTCHED TENSILE PROPERTIES OF AIR MELT-VACUUM ARC REMELT H-11 STEEL (HEAT NO. W-24341-1)

TRANSVERSE NOTCHED TENSILE PROPERTIES
OF AIR MELT-VACUUM ARC REMELT
H-11 STEEL HEAT NO. W-24341-1

BILLET SECTION	TEST NO.	SPECIMEN LOCATION	ULT STR KSI	N/S U.S. RATIO	BHN
A	1 4	S	256.7	0.82	555
A	5 4	S	245.5	0.83	555
A	12 4	S	237.5	0.82	578
A	20 4	M	198.3	0.66	555
A	21 4	M	173.2		555
A	26 4	M	148.8	0.49	555
A	27 4	M	184.7	0.60	555
A	38 4	M	210.2	0.71	555
A	39 4	M	174.9	0.59	532
A	60 4	C	161.3		544
A	62 4	C	117.5	0.41	555
B	1 4	S	211.8	0.73	555
B	5 4	S	271.0	0.93	555
B	12 4	S	269.8	0.93	578
B	20 4	M	186.0	0.69	555
B	21 4	M	166.5	0.55	555
B	26 4	M	174.4	0.58	555
B	27 4	M	205.3	0.67	555
B	38 4	M	182.0	0.62	555
B	39 4	M	214.9	0.71	532
B	60 4	C	173.3	0.59	544
B	62 4	C	125.2	0.54	555
C	1 4	S	244.4	0.88	555
C	5 4	S	218.9	0.76	555
C	12 4	S	232.9	0.78	578
C	20 4	M	217.7	0.75	555
C	21 4	M	203.3	0.71	555
C	26 4	M	152.8	0.51	555
C	27 4	M	179.7	0.62	555
C	38 4	M	220.9	0.75	555
C	39 4	M	235.8	0.82	532
C	60 4	C	215.2	0.75	544
C	62 4	C	157.3	0.57	555
D	1 4	S	235.2	0.80	555
D	5 4	S	268.0	0.92	555
D	12 4	S	230.9	0.78	578
D	20 4	M	162.4	0.56	555
D	21 4	M	162.1	0.56	555
D	26 4	M	164.7	0.55	555
D	27 4	M	155.8		555
D	38 4	M	261.3	0.90	555
D	39 4	M	155.5	0.54	532
D	60 4	C	168.8	0.61	544
D	62 4	C	181.9	0.64	555
E	1 4	S	248.5	0.83	555
E	5 4	S	247.5	0.84	555
E	12 4	S	261.0	0.87	578
E	20 4	M	182.9	0.63	555
E	21 4	M	213.5	0.74	555
E	26 4	M	224.5	0.74	555
E	27 4	M	229.9	0.78	555
E	38 4	M	198.4	0.68	555
E	39 4	M	149.7	0.52	532
E	60 4	C	171.2	0.61	544
E	62 4	C	196.3	0.69	555
H	1 4	S	210.5	0.72	555
H	5 4	S	226.0	0.78	555
H	12 4	S	249.2	0.83	578
H	20 4	M	219.7	0.74	555
H	21 4	M	248.3	0.85	555
H	26 4	M	208.7	0.71	555
H	27 4	M	186.5	0.65	555
H	38 4	M	245.5	0.84	555
H	39 4	M	173.4	0.60	532
H	60 4	C	142.8	0.50	544
H	62 4	C	184.0	0.65	555
I	1 4	S	248.3	0.83	555
I	5 4	S	284.2	0.99	555

BILLET SECTION	TEST NO.	SPECIMEN LOCATION	ULT STR KSI	N/S U.S. RATIO	BHN
I	12 4	S	270.8	0.91	578
I	20 4	M	251.8	0.85	555
I	21 4	M	175.2	0.61	555
I	26 4	M	214.9	0.71	555
I	27 4	M	191.0	0.66	555
I	38 4	M	235.2	0.81	555
I	39 4	M	174.4	0.62	532
I	60 4	C	197.5	0.69	544
I	62 4	C	149.2	0.52	555
J	1 4	S	253.2	0.87	555
J	5 4	S	283.8	1.02	555
J	12 4	S	167.5	0.60	578
J	20 4	M	262.0	0.90	555
J	21 4	M	240.5	0.83	555
J	26 4	M	241.0	0.80	555
J	27 4	M	213.4	0.72	555
J	38 4	M	252.5	0.88	555
J	39 4	M	215.1	0.74	532
J	60 4	C	148.0	0.50	544
J	62 4	C	190.0	0.67	555
K	1 4	S	221.6	0.76	555
K	5 4	S	253.6	0.88	555
K	12 4	S	250.9	0.85	555
K	20 4	M	241.7	0.82	534
K	21 4	M	150.5	0.52	534
K	26 4	M	179.8	0.67	534
K	27 4	M	181.4	0.62	534
K	38 4	M	246.4	0.84	534
K	39 4	M	211.2	0.74	532
K	60 4	C	215.0	0.75	534
K	62 4	C	217.7	0.77	534
L	1 4	S	263.7	0.90	555
L	5 4	S	265.9	0.92	555
L	12 4	S	262.6	0.89	555
L	20 4	M	260.0	0.89	555
L	21 4	M	165.8	0.57	534
L	26 4	M	236.8	0.79	534
L	27 4	M	218.2	0.75	534
L	38 4	M	170.8	0.59	534
L	39 4	M	170.5	0.60	532
L	60 4	C	206.0	0.73	534
L	62 4	C	204.5	0.72	534
M	1 4	S	268.8	0.92	555
M	5 4	S	237.2	0.81	555
M	12 4	S	141.0	0.48	555
M	20 4	M	151.9	0.53	534
M	21 4	M	099.4	0.35	534
M	26 4	M	244.6	0.82	534
M	27 4	M	191.3	0.65	534
M	38 4	M	261.8	0.94	534
M	39 4	M	204.8	0.71	532
M	60 4	C	134.4	0.47	534
M	62 4	C	172.2	0.61	534
N	1 4	S	251.3	0.85	555
N	5 4	S	227.0	0.79	555
N	12 4	S	257.6	0.88	555
N	20 4	M	212.3	0.75	534
N	21 4	M	146.2	0.50	534
N	26 4	M	168.8	0.58	534
N	27 4	M	185.6	0.65	534
N	38 4	M	216.2	0.75	534
N	39 4	M	149.6	0.53	532
N	60 4	C	202.5	0.73	534
N	62 4	C	171.0	0.61	534
P	1 4	S	230.9	0.79	555
P	5 4	S	244.4	0.86	555
P	12 4	S	263.5	0.88	555
P	20 4	M	185.6	0.64	534
P	21 4	M	191.9	0.66	534
P	26 4	M	216.9	0.74	534
P	27 4	M	200.5	0.69	534
P	38 4	M	256.2	0.89	534

BILLET SECTION	TEST NO.	SPECIMEN LOCATION	ULT STR KSI	N/S U.S. RATIO	BHN
P	39 4	M	207.8	0.72	532
P	60 4	C	159.4	0.56	534
P	62 4	C	190.0	0.69	534
S	1 4	S	239.0	0.82	555
S	5 4	S	249.0	0.87	555
S	12 4	S	258.5	0.88	555
S	20 4	M	209.3	0.72	534
S	21 4	M	200.9	0.69	534
S	26 4	M	211.1	0.71	534
S	27 4	M	162.6	0.56	534
S	38 4	M	220.9	0.77	534
S	39 4	M	183.0	0.65	532
S	60 4	C	186.5	0.66	534
S	62 4	C	206.4	0.72	534
T	1 4	S	282.6	0.97	555
T	5 4	S	245.5	0.85	555
T	12 4	S	208.5	0.72	555
T	20 4	M	235.0	0.82	555
T	21 4	M	158.0	0.54	534
T	26 4	M	242.4	0.82	534
T	27 4	M	214.8	0.73	534
T	38 4	M	240.3	0.84	534
T	39 4	M	186.9	0.66	532
T	60 4	C	153.3		534
T	62 4	C	198.8	0.71	534
V	1 4	S	233.9	0.81	555
V	5 4	S	229.0	0.80	555
V	12 4	S	142.7	0.53	555
V	20 4	M	234.5	0.82	555
V	21 4	M	180.2	0.62	534
V	26 4	M	195.0	0.67	534
V	27 4	M	209.4	0.72	534
V	38 4	M	200.5	0.70	534
V	39 4	M	267.1	0.92	532
V	60 4	C	174.3	0.61	534
V	62 4	C	182.4	0.64	534

SECTION 4

LONGITUDINAL NOTCHED TENSILE PROPERTIES OF AIR MELT-VACUUM ARC REMELT H-11 STEEL (HEAT NO. W-24341-1)

LONGITUDINAL NOTCHED TENSILE PROPERTIES
OF AIR MELT-VACUUM ARC REMELT
H-11 STEEL HEAT NO. W-24341-1

BILLET SECTION	TEST NO.	SPECIMEN LOCATION	ULT STR KSI	N/S U.S. RATIO	BHN
A	13 5	S	235.9	0.77	534
A	17 5	S	260.0	0.84	578
A	40 5	M	253.5	0.83	544
A	44 5	M	232.2	0.77	555
A	48 5	M	255.0	0.82	555
A	64 5	C	234.5	0.77	555
A	66 5	C	151.2	0.49	555
B	13 5	S	276.8	0.90	534
B	17 5	S	281.8	0.92	578
B	40 5	M	255.7	0.88	534
B	44 5	M	275.0	0.93	555
B	48 5	M	304.9		555
B	64 5	C	243.2	0.78	555
B	66 5	C	180.0	0.59	555
C	13 5	S	282.2	0.97	534
C	17 5	S	256.2	0.84	578
C	40 5	M	290.0	1.00	544
C	44 5	M	236.9	0.82	555
C	48 5	M	244.9	0.80	555
C	64 5	C	299.0	0.98	555
C	66 5	C	247.8	0.84	555
D	13 5	S	269.0	0.89	534
D	17 5	S	276.9	0.90	578
D	40 5	M	265.4	0.91	555
D	44 5	M	259.9	0.90	555
D	48 5	M	219.7	0.72	555
D	64 5	C	193.0	0.64	555
D	66 5	C	232.0	0.77	555
E	13 5	S	271.9	0.90	534
E	17 5	S	245.1	0.80	578
E	40 5	M	261.8	0.89	555
E	44 5	M	258.0	0.89	555
E	48 5	M	260.8	0.87	555
E	64 5	C	223.4	0.75	555
E	66 5	C	233.3	0.79	555
H	13 5	S	234.8	0.78	534
H	17 5	S	318.9	1.07	578
H	40 5	M	251.8	0.86	555
H	44 5	M	279.3	0.96	555
H	48 5	M	246.7	0.89	555
H	64 5	C	251.8	0.85	555
H	66 5	C	222.2	0.75	555
I	13 5	S	230.3	0.77	534
I	17 5	S	295.8	0.98	578
I	40 5	M	297.2	1.03	555
I	44 5	M	286.2	1.00	555
I	48 5	M	281.3	0.95	555
I	64 5	C	179.8	0.60	555
I	66 5	C	235.0	0.80	555
J	13 5	S	293.1	0.98	534
J	17 5	S	288.0	0.97	578
J	40 5	M	240.3	0.82	555
J	44 5	M	280.9	0.97	555
J	48 5	M	283.6	0.94	555
J	64 5	C	255.5	0.85	555
J	66 5	C	267.1	0.92	555
K	13 5	S	235.7	0.79	534
K	17 5	S	271.9	0.91	555
K	40 5	M	272.0	0.93	555
K	44 5	M	270.0	0.92	532
K	48 5	M	298.2	0.85	532
K	64 5	C	240.0	0.82	534
K	66 5	C	201.2	0.69	555
L	13 5	S	248.9	0.84	534
L	17 5	S	279.9	0.91	555

BILLET SECTION	TEST NO.	SPECIMEN LOCATION	ULT STR KSI	N/S U.S. RATIO	BHN
L	40 S	M	274.0	0.95	555
L	44 S	M	258.3	0.90	532
L	48 S	M	259.0	0.88	532
L	64 S	C	245.8	0.84	534
L	66 S	C	229.5	0.79	555
M	13 S	S	215.9	0.72	534
M	17 S	S	242.0	0.81	555
M	40 S	M	215.3	0.74	555
M	44 S	M	247.4	0.86	532
M	48 S	M	263.5	0.89	532
M	64 S	C	153.7	0.53	534
M	66 S	C	217.2	0.74	555
N	13 S	S	262.0	0.87	534
N	17 S	S	250.2	0.85	555
N	40 S	M	208.6	0.72	555
N	44 S	M	180.0	0.62	532
N	48 S	M	187.2	0.62	532
N	64 S	C	211.5	0.73	534
N	66 S	C	206.3	0.70	555
P	13 S	S	249.0	0.83	534
P	17 S	S	253.2	0.82	555
P	40 S	M	258.5	0.91	555
P	44 S	M	231.1	0.79	532
P	48 S	M	244.8	0.82	532
P	64 S	C	237.5	0.81	534
P	66 S	C	196.2	0.67	555
S	13 S	S	187.5	0.63	534
S	17 S	S	282.0	0.95	555
S	40 S	M	226.0	0.79	555
S	44 S	M	248.0	0.86	532
S	48 S	M	265.2	0.89	532
S	64 S	C	213.5	0.73	534
S	66 S	C	216.7	0.74	555
T	13 S	S	237.9	0.81	534
T	17 S	S	256.9	0.87	555
T	40 S	M	252.0	0.88	555
T	44 S	M	246.4	0.85	532
T	48 S	M	238.0	0.79	532
T	64 S	C	187.5	0.64	534
T	66 S	C	188.0	0.65	555
V	13 S	S	237.5	0.81	534
V	17 S	S	228.3	0.77	555
V	40 S	M	242.3	0.84	555
V	44 S	M	216.9	0.75	532
V	48 S	M	204.0	0.68	532
V	64 S	C	190.0	0.65	534
V	66 S	C	216.1	0.74	555

APPENDIX II

TENSILE PROPERTIES OF AIR MELT-DEGAS-VACUUM ARC REMELT H-11 STEEL (HEAT NO. W-24342-V1)

SECTION 1

TRANSVERSE TENSILE PROPERTIES OF
AIR MELT-DEGAS-VACUUM ARC REMELT H-11 STEEL
(HEAT NO. W-24342-V1)

TRANSVERSE TENSILE PROPERTIES
OF AIR MELT DEGAS-VACUUM ARC REMELT
H 11 STEEL HEAT NO. W 24342-V1

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
A	02 4	S	220.3	285.0	3.0	5.0	555
A	03 4	S	224.5	285.0	5.5	6.2	534
A	04 4	S	229.3	286.5	3.2	5.8	528
A	06 4	S	228.8	292.0	4.3	4.7	555
A	07 4	S	227.4	290.0	2.5	5.1	534
A	08 4	S	242.0	295.8	2.0	3.5	555
A	09 4	S	238.0	305.0	5.3	12.2	578
A	10 4	S	230.8	292.5	3.5	6.6	545
A	11 4	S	231.0	296.8	6.0	13.0	578
A	22 4	M	238.0	302.0	3.5	5.4	555
A	23 4	M	229.3	296.3	2.5	3.1	534
A	24 4	M	225.8	287.0	3.5	5.1	555
A	25 4	M	237.0	309.0	3.5	6.3	563
A	28 4	M	230.0	298.0	4.0	5.0	555
A	29 4	M	229.0	292.8	2.5	3.1	555
A	30 4	M	233.5	303.8	4.0	4.3	555
A	31 4	M	232.5	299.5	5.0	9.2	555
A	32 4	M	237.8	302.5	2.5	4.7	555
A	33 4	M	234.9	294.1	3.0	3.9	555
A	34 4	M	230.0	296.8	4.5	6.6	555
A	35 4	M	229.0	294.0	1.5	3.5	534
A	36 4	M	227.9	297.0	4.5	5.5	534
A	37 4	M	225.6	286.0	2.5	3.2	534
A	61 4	C	235.9	291.0	2.5	3.2	555
A	63 4	C	232.0	294.3	2.3	4.5	555
B	02 4	S	225.5	299.0	4.5	10.4	555
B	03 4	S	224.5	287.5	3.5	6.2	534
B	04 4	S	228.0	295.0	4.0	5.0	528
B	06 4	S	227.5	290.0	4.8	8.9	555
B	07 4	S	222.5	287.6	3.0	6.6	534
B	08 4	S	227.0	296.0	3.0	9.5	555
B	09 4	S	234.5	298.8	2.0	3.5	578
B	10 4	S	224.8	287.5	6.0	10.4	545
B	11 4	S	230.5	289.0	4.5	7.7	578
B	22 4	M	242.0	306.3	3.0	7.0	555
B	23 4	M	230.0	292.5	2.5	3.9	534
B	24 4	M	236.0	295.0	3.5	8.1	555
B	25 4	M	230.9	304.0	4.2	8.2	563
B	28 4	M	239.0	301.5	1.5	1.4	555
B	29 4	M	231.0	277.8	1.2	1.4	555
B	30 5	M	[illegible]	[illegible]	[illegible]	[illegible]	555
B	31 4	M	235.5	292.0	2.0	3.5	555
B	32 4	M	240.5	306.0	3.5	5.8	555
B	33 4	M	237.5	293.8	.5	1.1	555
B	34 4	M	233.0	305.0	3.5	5.4	555
B	35 4	M	233.0	290.3	2.0	3.1	534
B	36 4	M	226.8	297.5	4.5	6.6	534
B	37 4	M	230.6	293.2	2.5	4.4	534
B	61 4	C	242.3	305.0	3.5	3.9	555
B	63 4	C	236.5	296.3	1.8	3.9	555
C	02 4	S	224.0	287.5	5.0	11.1	555
C	03 4	S	229.1	292.2	6.0	11.1	534
C	04 4	S	223.3	291.0	3.5	7.7	528
C	06 4	S	228.5	294.3	6.5	13.4	545
C	07 4	S	225.0	296.5	4.0	5.0	534
C	08 4	S	220.5	287.0	3.5	7.0	555
C	09 4	S	232.5	298.8	3.0	4.3	578
C	10 4	S	226.0	289.9	3.5	4.7	545
C	11 4	S	225.0	291.1	4.0	6.6	578
C	22 4	M	247.0	312.5	3.0	5.0	555
C	23 4	M	232.0	300.0	2.0	3.1	534
C	24 4	M	241.1	304.5	2.5	3.6	555
C	25 4	M	241.3	305.0	2.2	4.7	563
C	28 4	M	237.5	291.0	1.2	3.1	555
C	29 4	M	237.8	294.5	1.5	2.7	555
C	30 4	M	237.0	305.0	4.0	11.9	555
C	31 4	M		203.5			555
C	32 4	M	242.3	299.8	1.3	1.1	555
C	33 4	M	239.0	297.5	2.0	7.0	555
C	34 4	M	235.5	300.5	3.0	5.0	555
C	35 4	M	230.0	290.0	1.5	2.3	534
C	36 4	M	225.3	300.0	3.2	5.8	534

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
C	37 4	M	229.3	286.3	1.5	3.1	534
C	61 4	C	230.3	293.8	2.5	3.5	555
C	63 4	C	233.5	295.0	3.0	4.3	555
D	02 4	S	223.3	286.9	3.8	7.0	555
D	03 4	S	226.0	291.0	5.0	8.9	534
D	04 4	S	226.0	286.0	6.0	11.1	528
D	06 4	S	226.8	292.3	5.5	9.6	555
D	07 4	S	221.9	285.0	4.5	10.0	534
D	08 4	S	222.3	287.8	6.2	8.1	555
D	09 4	S	234.3	296.3	5.8	12.6	578
D	10 4	S	233.0	296.0	3.0	3.1	555
D	11 4	S	230.5	297.5	4.5	7.7	578
D	22 4	M	243.5	307.5	2.5	3.9	555
D	23 4	M	234.3	303.8	3.0	3.9	534
D	24 4	M	238.0	298.8	2.5	3.5	555
D	25 4	M	233.3	305.0	4.5	8.9	563
D	28 4	M	228.8	292.8	4.5	8.5	555
D	29 4	M	237.5	295.8	1.5	2.3	555
D	30 4	M	238.5	307.5	3.0	3.5	555
D	31 4	M					555
D	32 4	M	234.5	296.3	3.3	5.0	555
D	33 4	M	232.5	292.5	2.0	3.9	555
D	34 4	M	224.8	298.0	3.0	4.0	555
D	35 4	M	226.8	278.8	1.5	2.3	534
D	36 4	M	219.3	295.0	4.0	7.7	534
D	37 4	M	227.0	288.0	3.0	3.5	534
D	61 4	C	234.5	294.7	2.0	4.7	555
D	63 4	C	234.5	290.1	1.5	4.0	555
E	02 4	S	230.0	293.0	4.5	7.0	555
E	03 4	S	225.8	286.5	4.0	6.2	534
E	04 4	S	226.3	291.0	2.5	5.0	528
E	06 4	S	229.3	294.5	5.5	9.2	555
E	07 4	S	224.9	288.2	5.0	10.3	534
E	08 4	S	226.6	295.4	3.0	5.1	555
E	09 4	S	231.7	300.8	3.8	5.5	578
E	10 4	S	231.0	295.0	4.0	6.6	555
E	11 4	S	232.5	293.7	6.0	13.3	578
E	22 4	M	239.0	307.3	4.0	5.0	555
E	23 4	M	231.5	294.5	1.5	4.3	534
E	24 4	M	234.5	302.5	3.5	6.2	555
E	25 4	M	240.0	301.0	1.8	5.0	563
E	28 4	M	230.0	297.8	6.5	12.6	555
E	29 4	M	231.5	293.8	1.8	3.1	555
E	30 4	M	233.5	290.8	2.5	5.4	555
E	31 4	M	230.0	290.0	2.0	4.3	555
E	32 4	M	239.0	302.5	6.3	12.2	555
E	33 4	M	236.5	299.5	2.5	7.0	555
E	34 4	M	222.5	294.3	5.5	7.7	555
E	35 4	M	227.1	304.5	2.5	4.7	534
E	36 4	M	223.8	294.2	4.0	8.5	534
E	37 4	M	230.0	291.0	3.0	1.4	534
E	61 4	C	231.1	291.1	3.0	5.9	555
E	63 4	C	233.1	291.6	2.0	3.6	555
H	02 4	S	227.5	296.9	5.8	12.6	555
H	03 4	S	233.5	296.8	4.5	8.5	534
H	04 4	S	228.3	293.3	6.0	11.9	528
H	06 4	S	223.8	285.8	3.0	5.0	545
H	07 4	S	226.3	288.6	5.0	8.1	534
H	08 4	S	223.4	287.6	3.0	8.1	555
H	09 4	S	236.8	302.5	5.3	10.7	578
H	10 4	S	226.5	288.5	5.0	6.2	555
H	11 4	S	227.4	288.6	5.0	7.0	578
H	22 4	M	240.8	305.0	3.5	5.4	555
H	23 4	M	233.9	293.2	1.5	2.3	534
H	24 4	M	230.2	294.5	3.5	5.9	555
H	25 4	M	238.0	302.5	5.0	6.6	563
H	28 4	M	230.3	291.8	5.0	10.7	555
H	29 4	M	229.8	295.8	2.5	2.7	555
H	30 4	M	232.5	299.5	2.5	5.0	555
H	31 4	M	235.0	304.8	2.5	3.1	555
H	32 4	M	239.3	303.8	3.5	7.0	555
H	33 4	M	234.5	295.0	2.0	5.0	555
H	34 4	M	229.5	295.0	3.5	5.0	555
H	35 4	M	229.8	305.0	2.5	3.9	534
H	36 4	M	220.8	297.5	4.5	7.7	534

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
H	37 4	M	230.0	293.9	2.0	5.4	534
H	61 4	C	231.1	293.9	2.5	2.4	555
H	63 4	C	234.0	291.8	2.0	4.3	555
I	02 4	S	227.5	296.3	4.0	6.6	555
I	03 4	S	225.0	289.3	2.5	3.9	534
I	04 4	S	224.0	283.3	5.0	8.1	528
I	06 4	S	231.8	293.8	3.3	5.4	555
I	07 4	S	219.2	282.0	5.0	9.3	534
I	08 4	S	219.0	285.5	3.5	3.9	555
I	09 4	S	228.3	297.5	5.5	10.7	578
I	10 4	S	226.0	286.5	5.0	11.9	555
I	11 4	S	233.5	298.4	6.5	14.8	578
I	22 4	M	241.5	302.5	5.0	8.1	555
I	23 4	M	225.5	288.0	2.5	3.5	534
I	24 4	M	227.5	288.8	4.5	6.6	555
I	25 4	M	238.3	305.0	2.5	4.3	563
I	28 4	M	239.0	305.0	3.5	8.5	555
I	29 4	M	231.8	294.5	2.2	3.5	555
I	30 4	M	241.5	310.0	3.5	8.1	555
I	31 4	M	239.0	303.8	4.0	5.8	555
I	32 4	M	239.5	302.5	5.3	11.1	555
I	33 4	M	232.0	292.8	2.0	2.7	555
I	34 4	M	225.5	291.8	2.0	2.7	555
I	35 4	M	228.8	295.0	1.8	3.5	534
I	36 4	M	226.0	293.8	2.5	5.0	534
I	37 4	M	226.5	287.2	2.5	2.4	534
I	61 4	C	231.1	298.1	3.5	4.7	555
I	63 4	C	233.0	297.5	3.5	4.3	555
J	02 4	S	225.0	291.0	3.0	5.8	555
J	03 4	S	224.0	286.6	2.0	4.7	534
J	04 4	S	233.0	290.5	5.0	7.3	528
J	06 4	S	227.0	285.8	4.3	6.2	555
J	07 4	S	223.8	285.2	6.0	7.4	534
J	08 4	S	230.5	295.8	2.5	5.4	555
J	09 4	S	226.0	291.3	3.5	6.2	578
J	10 4	S	230.0	287.5	2.0	3.5	545
J	11 4	S	228.0	291.3	3.5	5.4	578
J	22 4	M	240.0	301.3	2.5	4.7	555
J	23 4	M	230.5	299.0	3.0	1.9	534
J	24 4	M	239.0	305.0	3.0	4.7	555
J	25 4	M	238.3	307.5	5.0	10.4	563
J	28 4	M	233.5	303.8	4.2	6.6	555
J	29 4	M	232.0	299.3	2.2	4.3	555
J	30 4	M	235.0	306.5	4.5	5.8	555
J	31 4	M	232.0	298.0	5.0	10.0	555
J	32 4	M	238.8	306.3	4.3	5.0	555
J	33 4	M	230.0	290.5	2.0	2.7	555
J	34 4	M	229.1	294.7	3.0	6.7	555
J	35 4	M	226.9	299.3	2.5	3.2	534
J	36 4	M	221.8	296.3	4.8	8.1	534
J	37 4	M	230.5	285.8	2.0	3.1	534
J	61 4	C	234.8	287.5	2.0	2.8	555
J	63 4	C	232.5	294.8	3.0	5.0	555
K	02 4	S	229.5	299.3	4.5	10.0	555
K	03 4	S	225.0	282.5	5.0	11.1	534
K	04 4	S	225.0	284.5	5.0	8.1	528
K	06 4	S	220.8	282.5	3.5	5.4	534
K	07 4	S	227.9	291.0	5.0	10.3	555
K	08 4	S	235.2	299.2	4.5	9.3	534
K	09 4	S	233.1	299.8	5.5	11.5	563
K	10 4	S	227.5	292.0	6.0	12.2	555
K	11 4	S	228.0	291.8	6.5	13.6	555
K	22 4	M	237.5	293.8	1.0	3.1	534
K	23 4	M	229.5	293.5	2.5	3.9	555
K	24 4	M	239.3	302.5	4.0	6.6	555
K	25 4	M	239.2	305.8	5.0	8.6	555
K	28 4	M	229.0	295.8	2.0	6.6	555
K	29 4	M	231.0	293.8	2.0	2.7	555
K	30 4	M	239.0	308.8	4.5	9.6	555
K	31 4	M	232.0	297.8	2.5	4.3	555
K	32 4	M	235.0	297.5	2.0	2.7	555
K	33 4	M	231.5	289.8	3.5	5.8	555
K	34 4	M	228.0	300.5	3.0	5.9	534
K	35 4	M	218.8	292.5	2.5	4.3	555
K	36 4	M	220.8	295.0	5.0	8.9	555

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
K	37 4	M	226.3	289.0	2.3	4.6	534
K	61 4	C	235.0	292.5	3.0	5.4	555
K	63 4	C	231.5	295.3	3.0	4.3	555
L	02 4	S	223.0	285.7	4.0	8.1	555
L	03 4	S	223.8	283.3	5.0	8.5	534
L	04 4	S	226.0	291.5	5.5	10.0	534
L	06 4	S	230.5	289.8	4.5	5.8	528
L	07 4	S	219.5	257.3	1.0	1.1	555
L	08 4	S	228.5	292.2	4.5	7.4	534
L	09 4	S	233.9	299.8	5.8	10.8	563
L	10 4	S	238.3	305.0	3.8	6.2	555
L	11 4	S	235.0	282.5	1.2	2.7	555
L	22 4	M	237.5	296.0	2.5	3.5	534
L	23 4	M	227.0	285.3	3.0	3.5	555
L	24 4	M	225.5	287.5	3.5	6.6	555
L	25 4	M	232.0	305.0	5.2	8.5	555
L	28 4	M	239.5	308.3	5.0	8.9	555
L	29 4	M	232.3	300.0	2.2	3.1	555
L	30 4	M	237.5	305.7	4.0	8.6	555
L	31 4	M	236.1	304.4	3.0	3.6	555
L	32 4	M	235.0	301.3	3.3	3.9	555
L	33 4	M	239.5	292.3	2.0	3.5	559
L	34 4	M	229.5	297.3	4.5	7.3	534
L	35 4	M	223.3	288.8	1.5	2.7	555
L	36 4	M	220.8	295.0	5.0	5.8	555
L	37 4	M	228.0	297.5	5.5	10.0	534
L	61 4	C	230.5	288.1	2.0	2.0	555
L	63 4	C	232.5	295.3	3.0	7.0	555
M	02 4	S	226.3	291.5	3.5	5.0	544
M	03 4	S	231.5	294.8	7.5	15.6	534
M	04 4	S	225.5	286.5	6.0	7.3	534
M	06 4	S	227.0	286.8	5.5	11.5	534
M	07 4	S	219.5	281.4	4.5	9.6	555
M	08 4	S	222.5	290.0	6.0	9.7	534
M	09 4	S	234.3	301.0	6.3	15.9	563
M	10 4	S	228.0	296.0	5.2	10.0	555
M	11 4	S	229.3	288.5	7.0	13.7	555
M	22 4	M	241.0	307.5	2.0	2.3	534
M	23 4	M	239.5	307.5	3.0	4.3	555
M	24 4	M	228.3	287.5	2.5	4.3	555
M	25 4	M	237.6	298.2	1.5	2.0	555
M	28 4	M	233.1	298.0	6.0	12.3	555
M	29 4	M	233.3	292.0	1.5	3.1	559
M	30 4	M	239.5	306.5	6.0	13.4	555
M	31 4	M	236.5	307.3	3.0	3.2	555
M	32 4	M	235.3	294.8	2.0	3.9	555
M	33 4	M	238.0	300.5	3.5	5.8	555
M	34 4	M	222.5	295.8	6.0	7.0	534
M	35 4	M	228.3	303.8	2.2	4.8	555
M	36 4	M	222.3	295.0	5.5	6.6	555
M	37 4	M	227.0	292.5	3.0	3.9	534
M	61 4	C	232.4	295.8	3.0	4.0	555
M	63 4	C	228.5	299.3	3.5	6.6	555
N	02 4	S	247.5	285.3	3.0	7.0	555
N	03 4	S	224.5	286.8	5.0	11.9	534
N	04 4	S	222.3	285.3	5.0	8.5	528
N	06 4	S	227.5	293.5	7.5	11.9	528
N	07 4	S	225.5	294.8	4.5	8.9	555
N	08 4	S	224.0	288.0	5.0	6.6	534
N	09 4	S	227.3	291.9	3.0	5.8	563
N	10 4	S	219.2	274.6	1.8	4.3	555
N	11 4	S	232.0	294.3	4.0	4.3	555
N	22 4	M	244.5	300.5	4.3	5.5	534
N	23 4	M	228.5	288.0	2.0	2.7	555
N	24 4	M	232.6	298.1	4.5	6.3	555
N	25 4	M	236.3	307.1	3.0	2.8	555
N	28 4	M	232.3	295.8	5.8	13.0	559
N	29 4	M	224.5	290.0	3.0	5.4	555
N	30 4	M	240.0	307.5	5.0	6.2	555
N	31 4	M	234.5	300.5	4.5	9.2	555
N	32 4	M	236.0	295.0	1.8	1.9	555
N	33 4	M	231.5	296.0	3.5	3.9	555
N	34 4	M	223.8	293.9	5.0	7.4	534
N	35 4	M	228.3	300.0	2.5	4.7	555
N	36 4	M	220.4	293.1	2.8	5.1	555

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
N	37 4	M	226.5	290.3	1.8	2.8	534
N	61 4	C	230.8	288.8	2.5	2.3	555
N	63 4	C	233.5	280.5		8	555
P	02 4	S	220.3	287.5	4.3	8.1	544
P	03 4	S	229.0	293.8	5.5	10.4	534
P	04 4	S	229.5	295.5	6.0	9.2	534
P	06 4	S	222.5	283.0	2.2	4.7	528
P	07 4	S	218.9	276.2	2.5	3.5	555
P	08 4	S	228.4	296.1	6.0	8.1	534
P	09 4	S	227.0	291.3	4.8	9.6	563
P	10 4	S	229.7	295.0	5.5	10.0	555
P	11 4	S	231.0	298.0	6.2	6.6	555
P	22 4	M	237.8	297.5	1.5	3.9	534
P	23 4	M	227.0	291.8	3.0	5.0	555
P	24 4	M		291.3	5.0	6.2	555
P	25 4	M	238.3	307.5	4.8	9.6	555
P	26 4	M	235.3	300.5	3.5	6.2	555
P	29 4	M	228.0	293.5	2.5	3.9	555
P	30 4	M	241.5	307.5	2.0	4.7	555
P	31 4	M	236.5	302.5	4.0	7.0	555
P	32 4	M	237.0	297.5	6.8	16.6	555
P	33 4	M	234.5	301.0	3.5	7.3	555
P	34 4	M	220.5	290.8	4.0	5.5	534
P	35 4	M	224.3	305.0	5.0	7.0	555
P	36 4	M	223.5	291.0	5.0	9.2	555
P	37 4	M	232.5	291.8	5.0	8.3	534
P	61 4	C	226.3	295.0	4.5	4.3	555
P	63 4	C	231.0	293.0	3.0	6.2	555
S	02 4	S	248.0	288.5	4.0	5.0	555
S	03 4	S	225.0	290.3	5.0	7.0	534
S	04 4	S	223.3	286.3	8.5	18.8	528
S	06 4	S	223.3	287.5	3.8	5.0	534
S	07 4	S	226.0	283.5	2.5	2.3	555
S	08 4	S	227.0	290.5	5.0	8.5	534
S	09 4	S	231.8	300.0	5.0	9.2	563
S	10 4	S	232.5	298.3	6.5	13.4	555
S	11 4	S	233.5	296.0	5.0	9.2	555
S	22 4	M	238.9	302.2	3.0	4.0	534
S	23 4	M	223.0	285.8	2.5	1.9	555
S	24 4	M	233.3	296.3	3.5	5.8	555
S	25 4	M	235.0	310.0	5.5	7.3	555
S	26 4	M	232.5	300.5	5.5	10.0	555
S	29 4	M	232.5	298.8	2.8	4.7	555
S	30 4	M	236.7	307.1	3.0	4.7	555
S	31 4	M	232.5	296.3	4.0	6.2	555
S	32 4	M	238.2	302.5	4.0	6.8	555
S	33 4	M	230.9	296.0	3.0	5.1	555
S	34 4	M	228.0	298.5	5.0	8.2	534
S	35 4	M	225.5	300.0	2.5	4.7	555
S	36 4	M	226.5	294.3	7.0	13.0	555
S	37 4	M	230.0	295.7	3.5	5.5	534
S	61 4	C	232.6	293.4	3.0	3.2	555
S	63 4	C	230.4	292.1	2.5	5.5	555
T	02 4	S	222.1	282.9	2.5	7.4	555
T	03 4	S	220.5	292.0	6.5	10.4	534
T	04 4	S	220.0	282.8	5.0	8.1	528
T	06 4	S	228.3	293.3	8.0	16.3	528
T	07 4	S	218.2	288.1	6.5	11.5	555
T	08 4	S	224.0	291.4	6.0	9.6	534
T	09 4	S	229.0	295.7	3.5	4.7	563
T	10 4	S	223.0	282.3	3.8	4.3	555
T	11 4	S	227.0	283.0	1.8	3.5	555
T	22 4	M	237.8	298.8	3.8	7.2	534
T	23 4	M	228.5	290.8	3.0	5.8	555
T	24 4	M	238.0	302.1	5.5	10.4	555
T	25 4	M	235.5	302.0	5.0	10.0	555
T	26 4	M	225.5	290.5	3.0	5.8	555
T	29 4	M	227.8	297.5	3.2	4.3	555
T	30 4	M	235.0	300.8	5.0	9.2	555
T	31 4	M	226.5	290.5	3.5	6.2	555
T	32 4	M	234.5	296.3	6.8	14.8	555
T	33 4	M	230.2	291.1	4.5	6.6	555
T	34 4	M	233.7	297.4	5.0	7.8	534
T	35 4	M	224.2	303.0	3.5	4.7	555
T	36 4	M	225.6	295.7	7.0	14.9	555

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
T	37 4	M	228.2	290.3	3.0	5.3	534
T	61 4	C	232.4	295.3	3.5	14.7	555
T	63 4	C	227.5	264.2	.8	2.0	555
V	02 4	S	225.0	283.3	4.0	7.3	555
V	03 4	S	225.0	284.0	2.0	5.4	534
V	04 4	S	225.8	292.5	5.0	8.5	528
V	06 4	S	226.0	286.0	5.8	10.7	534
V	07 4	S	227.5	292.8	3.0	4.7	555
V	08 4	S	223.5	290.5	7.0	14.5	534
V	09 4	S	231.7	297.0	3.0	5.1	563
V	10 4	S	225.0	264.0	1.2	2.3	555
V	11 4	S	233.3	295.3	5.5	12.2	555
V	22 4	M	232.5	300.0	3.0	7.7	555
V	23 4	M	232.5	296.8	2.0	3.5	555
V	24 4	M	228.0	290.0	3.5	4.3	555
V	25 4	M	232.0	293.8	6.0	12.6	555
V	28 4	M	228.1	292.4	5.5	10.8	555
V	29 4	M	224.3	285.7	1.5	3.6	555
V	30 4	M	232.5	293.3	3.5	7.7	555
V	31 4	M	228.0	292.3	3.0	5.8	555
V	32 4	M	232.9	298.0	6.3	11.2	555
V	33 4	M	228.5	289.5	3.0	4.7	555
V	34 4	M	223.0	293.2	5.0	7.8	534
V	35 4	M	222.5	296.3	2.5	4.7	555
V	36 4	M	225.0	294.8	6.0	9.6	555
V	37 4	M	223.7	289.2	3.8	5.9	534
V	61 4	C	239.1	294.5	2.0	3.2	555
V	63 4	C	232.5	295.0	1.5	2.3	555

SECTION 2

LONGITUDINAL TENSILE PROPERTIES OF AIR MELT-DEGAS-VACUUM ARC REMELT H-11 STEEL (HEAT NO. W-24342-V1)

LONGITUDINAL TENSILE PROPERTIES
OF AIR MELT DEGAS-VACUUM ARC REMELT
H 11 STEEL HEAT NO. W 24342-V1

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
A	14 S	S	232.5	296.5	4.0	6.6	544
A	15 S	S	228.0	295.3	5.0	10.0	555
A	16 S	S	239.3	298.8	5.0	11.5	555
A	18 S	S	243.8	308.8	5.5	13.0	555
A	41 S	M	230.3	300.0	3.0	4.7	555
A	42 S	M	233.5	301.3	4.0	11.9	578
A	43 S	M	239.1	300.5	3.0	5.1	578
A	45 S	M	232.8	301.3	4.0	6.2	578
A	46 S	M	234.2	307.0	4.2	7.0	555
A	47 S	M	234.0	306.3	2.5	4.3	578
A	49 S	M	239.0	308.0	3.8	4.8	578
A	50 S	M	230.0	307.5	5.0	9.2	555
A	51 S	M	234.0	297.5	2.5	4.3	578
A	65 S	C	233.6	300.6	2.8	5.3	555
A	67 S	C	234.5	302.5	3.0	5.8	555
B	14 S	S	230.8	295.5	7.8	18.1	544
B	15 S	S	224.4	285.1	7.0	18.1	555
B	16 S	S	227.5	287.5	5.5	13.0	555
B	18 S	S	237.5	308.8	5.5	8.9	555
B	41 S	M	230.0	305.0	3.5	5.8	555
B	42 S	M	243.2	306.1	3.0	15.2	578
B	43 S	M	240.9	303.3	2.8	5.9	578
B	45 S	M	234.8	302.5	3.8	5.4	578
B	46 S	M	235.5	303.8	6.0	8.9	555
B	47 S	M	236.5	301.5	2.5	5.4	578
B	49 S	M	237.6	307.0	3.0	5.9	578
B	50 S	M	231.5	310.0	4.5	9.6	555
B	51 S	M	236.8	305.7	3.8	5.5	578
B	65 S	C	236.5	303.8	3.5	5.8	555
B	67 S	C	231.8	300.0	2.8	4.7	555
C	14 S	S	229.0	291.8	8.0	23.0	544
C	15 S	S	219.5	278.8	7.0	13.7	544
C	16 S	S	233.4	298.0	6.5	13.0	555
C	18 S	S	234.8	306.3	5.3	8.5	555
C	41 S	M	233.0	306.3	3.0	6.6	555
C	42 S	M	241.1	304.9	3.5	7.0	578
C	43 S	M	240.0	303.3	3.5	7.0	578
C	45 S	M	232.3	302.5	3.0	5.0	578
C	46 S	M	240.0	311.3	4.2	8.1	555
C	47 S	M	240.0	310.0	2.5	4.3	578
C	49 S	M	239.0	304.5	3.5	5.9	578
C	50 S	M	232.5	307.5	6.0	8.5	555
C	51 S	M	233.5	300.0	2.0	2.3	578
C	65 S	C	231.0	298.3	5.0	9.6	555
C	67 S	C	238.5	303.8	3.5	6.2	555
D	14 S	S	225.2	284.7	5.8	9.6	544
D	15 S	S	233.5	295.6	7.0	20.9	555
D	16 S	S	230.0	291.8	7.0	19.9	555
D	18 S	S	236.8	303.8	6.0	10.0	555
D	41 S	M	238.8	305.0	3.5	5.8	555
D	42 S	M	237.5	301.3	6.0	16.6	578
D	43 S	M	241.0	303.3	5.8	5.8	578
D	45 S	M	229.3	298.8	3.8	5.0	578
D	46 S	M	235.5	308.8	4.0	7.0	555
D	47 S	M	234.5	303.8	4.5	5.4	578
D	49 S	M	236.8	304.4	3.5	5.1	578
D	50 S	M	231.0	307.0	4.5	4.4	555
D	51 S	M	234.0	302.0	3.8	6.3	578
D	65 S	C	230.0	298.3	4.0	7.7	555
D	67 S	C	233.5	305.0	3.2	3.9	555
E	14 S	S	225.0	286.5	9.0	20.0	544
E	15 S	S	219.5	278.1	7.0	16.6	544
E	16 S	S	238.8	300.5	6.8	16.6	555
E	18 S	S	239.0	308.5	5.5	11.5	555
E	41 S	M	234.8	302.5	3.0	5.0	555
E	42 S	M	236.0	303.8	6.0	2.7	578
E	43 S	M	235.3	302.1	3.0	4.0	578
E	45 S	M	232.3	303.8	4.2	4.3	578
E	46 S	M	230.3	298.8	5.8	13.4	555
E	47 S	M	240.0	306.1	3.5	5.8	578

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
E	49 S	M	230.6	309.4	3.5	6.3	578
E	50 S	M	229.5	294.5	4.5	7.0	555
E	51 S	M	236.0	303.8	3.3	4.7	578
E	65 S	C	234.0	295.9	4.5	10.4	555
E	67 S	C	231.0	305.0	4.0	10.4	555
H	14 S	S	224.3	288.8	7.0	14.1	544
H	15 S	S	224.0	286.3	6.0	12.2	544
H	16 S	S	225.0	287.3	6.5	16.3	555
H	18 S	S	235.0	303.5	6.3	10.7	555
H	41 S	M	233.8	303.8	3.2	5.0	555
H	42 S	M	237.8	302.2	6.5	16.0	578
H	43 S	M	237.5	298.0	5.0	8.5	578
H	45 S	M	228.7	300.9	3.5	4.7	578
H	46 S	M	230.5	301.3	5.0	12.2	555
H	47 S	M	236.0	302.5	3.0	6.2	578
H	49 S	M	227.3	298.2	2.8	6.6	578
H	50 S	M	227.8	303.2	6.0	12.6	563
H	51 S	M	238.5	306.8	3.8	5.0	578
H	65 S	C	231.0	296.0	3.0	6.7	555
H	67 S	C	233.0	305.0	4.0	7.7	555
I	14 S	S	222.0	282.0	6.0	13.7	544
I	15 S	S	231.0	295.0	5.0	10.4	544
I	16 S	S	233.0	293.8	5.0	7.7	555
I	18 S	S	235.3	300.0	6.5	11.8	555
I	41 S	M	234.5	303.8	3.2	4.3	555
I	42 S	M	240.5	302.5	5.0	13.0	578
I	43 S	M	235.0	297.1	2.8	4.7	578
I	45 S	M	233.3	302.5	2.5	4.3	578
I	46 S	M	232.0	302.5	3.8	7.0	555
I	47 S	M	233.0	302.5	4.0	7.7	578
I	49 S	M	242.2	314.3	5.0	6.0	578
I	50 S	M	225.0	303.8	3.0	7.7	555
I	51 S	M	235.3	300.2	3.5	7.0	578
I	65 S	C	233.0	297.5	3.0	5.0	555
I	67 S	C	229.3	300.0	4.2	6.6	555
J	14 S	S	222.5	283.5	5.5	10.0	544
J	15 S	S	230.0	292.0	5.0	10.4	555
J	16 S	S	233.5	299.8	6.5	10.4	555
J	18 S	S	234.0	300.0	7.0	15.2	555
J	41 S	M	230.3	300.0	3.5	3.8	555
J	42 S	M	238.0	305.0	5.0	8.5	578
J	43 S	M	239.0	299.5	3.5	7.0	578
J	45 S	M	232.0	302.5	2.8	3.5	578
J	46 S	M	233.8	308.8	4.0	6.6	555
J	47 S	M	237.5	306.3	3.5	5.8	578
J	49 S	M	231.5	302.0	4.0	7.4	578
J	50 S	M	229.4	306.1	3.5	10.0	555
J	51 S	M	233.3	297.0	3.0	5.5	578
J	65 S	C	234.5	296.0	4.5	8.9	555
J	67 S	C	228.3	296.3	4.0	6.2	555
K	14 S	S	220.8	281.1	5.5	13.8	544
K	15 S	S	223.0	282.5	6.3	15.2	563
K	16 S	S	232.5	303.5	5.5	10.4	555
K	18 S	S	242.5	307.5	5.5	10.4	555
K	41 S	M	235.8	303.8	3.2	5.0	578
K	42 S	M	231.1	294.6	4.0	5.9	578
K	43 S	M	235.0	297.5	2.5	4.7	555
K	45 S	M	225.0	301.3	2.5	4.3	555
K	46 S	M	235.3	305.0	4.0	5.0	555
K	47 S	M	237.5	305.0	4.0	4.3	578
K	49 S	M	237.4	302.1	3.0	6.3	578
K	50 S	M	234.0	308.8	4.5	6.6	555
K	51 S	M	235.9	300.9	3.0	4.2	555
K	65 S	C	230.8	298.0	3.0	6.1	555
K	67 S	C					555
L	14 S	S	230.5	294.2	5.5	10.8	544
L	15 S	S	225.5	287.0	6.5	13.1	555
L	16 S	S	230.3	292.5	4.0	5.8	555
L	18 S	S	233.5	301.3	4.8	9.6	555
L	41 S	M	233.0	302.5	2.8	4.3	578
L	42 S	M	238.1	300.9	3.5	5.9	578
L	43 S	M	237.0	302.0	3.5	7.0	555
L	45 S	M	235.0	302.8	4.2	6.6	555

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
L	46 S	M	233.6	304.6	5.2	8.9	555
L	47 S	M	233.5	306.3	4.5	6.2	578
L	49 S	M	238.2	300.0	2.4	2.5	578
L	50 S	M	228.0	306.3	5.5	8.9	555
L	51 S	M	235.1	300.0	3.3	4.9	555
L	65 S	C	230.0	294.6	4.5	10.1	555
L	67 S	C	227.5	298.8	4.0	5.4	555
M	14 S	S	230.0	293.3	8.5	23.7	544
M	15 S	S	231.0	291.0	5.5	14.1	555
M	16 S	S	232.3	293.8	5.5	11.1	555
M	18 S	S	231.5	303.8	7.5	14.8	555
M	41 S	M	235.5	302.5	5.0	11.9	578
M	42 S	M	237.0	302.5	4.0	11.9	578
M	43 S	M	239.8	295.0	4.3	8.9	555
M	45 S	M	231.9	298.3	4.2	5.5	555
M	46 S	M	234.3	302.1	6.0	11.6	555
M	47 S	M	235.0	303.8	3.8	5.4	578
M	49 S	M	235.0	302.0	3.8	4.7	578
M	50 S	M	231.1	307.0	6.0	9.3	563
M	51 S	M	236.3	303.1	3.3	5.5	555
M	65 S	C	232.6	298.3	3.8	5.1	555
M	67 S	C					555
N	14 S	S	225.5	290.1	5.0	11.2	544
N	15 S	S	225.5	288.1	8.0	22.1	563
N	16 S	S	232.3	294.5	7.8	19.2	555
N	18 S	S	232.3	297.5	7.5	15.2	555
N	41 S	M	235.5	300.0	4.5	6.6	578
N	42 S	M	238.0	302.5	4.5	11.5	578
N	43 S	M	239.0	301.3	4.0	6.6	555
N	45 S	M	231.8	302.5	3.2	3.9	555
N	46 S	M	234.8	303.8	5.5	10.7	555
N	47 S	M	234.0	305.0	3.5	6.6	578
N	49 S	M	239.1	299.5	2.5	4.7	578
N	50 S	M	227.5	307.5	5.3	8.9	563
N	51 S	M	233.5	300.8	2.5	4.7	555
N	65 S	C	227.5	297.0	4.5	8.5	555
N	67 S	C	224.3	298.8	4.5	7.3	555
P	14 S	S	225.0	286.0	2.5	4.3	544
P	15 S	S	221.5	286.9	5.3	11.1	563
P	16 S	S	226.5	289.8	8.0	15.6	555
P	18 S	S	232.8	305.0	8.5	20.6	555
P	41 S	M	233.8	305.0	3.5	6.2	578
P	42 S	M	235.5	300.0	5.5	11.1	578
P	43 S	M	237.3	300.4	3.5	5.9	555
P	45 S	M	232.5	300.0	2.2	3.9	555
P	46 S	M	231.8	303.8	6.0	10.7	555
P	47 S	M	245.8	304.7	4.5	7.8	578
P	49 S	M	235.0	304.5	5.5	8.2	578
P	50 S	M	228.7	303.3	6.5	12.3	555
P	51 S	M	230.5	295.8	2.8	4.0	555
P	65 S	C	230.7	293.9	4.5	8.6	555
P	67 S	C	230.3	298.8	5.2	7.0	555
S	14 S	S	220.8	281.5	8.2	16.6	544
S	15 S	S	230.5	294.3	5.5	16.3	555
S	16 S	S	227.0	294.5	5.5	11.9	555
S	18 S	S	234.3	306.0	7.3	14.1	555
S	41 S	M	230.5	301.3	3.5	6.6	578
S	42 S	M	234.0	303.8	4.5	7.3	578
S	43 S	M	236.0	299.7	4.5	7.6	555
S	45 S	M	234.3	301.3	4.5	7.7	555
S	46 S	M	232.5	306.3	5.8	11.9	555
S	47 S	M	234.8	303.8	4.5	8.1	578
S	49 S	M	234.6	303.0	4.0	6.0	578
S	50 S	M	225.0	302.2	6.5	14.9	555
S	51 S	M	232.9	299.7	4.3	8.4	555
S	65 S	C	231.5	297.0	5.5	10.7	555
S	67 S	C	227.3	300.0	5.0	6.2	555
T	14 S	S	229.3	294.5	5.0	8.5	544
T	15 S	S	228.0	294.5	4.0	22.3	555
T	16 S	S	230.8	296.3	7.0	16.6	555
T	18 S	S	228.0	296.3	6.3	11.9	555
T	41 S	M	234.0	300.0	6.0	9.2	578
T	42 S	M	232.5	299.3	6.5	22.7	578

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
T	43 S	M	230.0	299.0	5.5	8.9	555
T	45 S	M	230.0	302.5	5.0	7.3	555
T	46 S	M	228.8	296.3	6.5	13.7	555
T	47 S	M	235.0	302.5	4.5	7.3	578
T	49 S	M	234.2	301.8	4.0	7.5	578
T	50 S	M	230.0	306.3	5.0	8.5	555
T	51 S	M	235.3	301.3	4.8	7.7	555
T	65 S	C	233.0	299.6	2.5	5.1	555
T	67 S	C	230.5	300.0	4.0	5.8	555
V	14 S	S	224.0	287.0	9.0	23.5	544
V	15 S	S	219.3	278.1	8.5	22.3	563
V	16 S	S	229.5	289.3	7.8	15.9	555
V	18 S	S	236.3	305.0	8.3	21.3	555
V	41 S	M	226.0	290.0	5.5	13.0	578
V	42 S	M	236.0	297.5	8.0	21.3	578
V	43 S	M	230.0	292.5	4.8	10.7	555
V	45 S	M	232.3	302.5	5.0	6.2	555
V	46 S	M	231.3	303.8	4.5	8.1	555
V	47 S	M	230.0	307.5	4.0	7.7	578
V	49 S	M	227.7	295.5	7.5	16.1	578
V	50 S	M	227.0	301.7	8.0	20.9	555
V	51 S	M	228.5	293.1	4.8	11.2	555
V	65 S	C	238.0	311.3	3.0	5.8	555
V	67 S	C	231.5	301.3	4.0	5.0	555

SECTION 3

TRANSVERSE NOTCHED TENSILE PROPERTIES OF AIR MELT-DEGAS-VACUUM ARC REMELT H-11 STEEL (HEAT NO. W-24342-V1)

TRANSVERSE NOTCHED TENSILE PROPERTIES OF AIR MELT-DEGAS-VACUUM ARC REMELT H-11 STEEL HEAT NO. W-24342-V1

BILLET SECTION	TEST NO.	SPECIMEN LOCATION	ULT STR KSI	N/S U.S. RATIO	BHN
A	1 4	S	235.3	0.83	555
A	5 4	S	255.1	0.88	555
A	12 4	S	262.2	0.88	555
A	20 4	M	275.0	0.96	563
A	21 4	M	166.0	0.56	555
A	26 4	M	172.3	0.57	555
A	27 4	M	203.9	0.70	555
A	38 4	M	161.3	0.54	534
A	39 4	M	227.8	0.79	534
A	60 4	C	179.3	0.62	555
A	62 4	C	184.5	0.63	555
B	1 4	S	146.0	0.51	555
B	5 4	S	229.0	0.80	555
B	12 4	S	260.9	0.90	555
B	20 4	M	176.8	0.60	563
B	21 4	M	195.5	0.67	555
B	26 4	M	215.9	0.70	555
B	27 4	M	153.3	0.55	555
B	38 4	M	222.0	0.75	534
B	39 4	M	194.8	0.66	534
B	60 4	C	236.0	0.77	555
B	62 4	C	191.0	0.64	555
C	1 4	S	232.5	0.80	555
C	5 4	S	228.6	0.77	555
C	12 4	S	182.5	0.63	555
C	20 4	M	174.8	0.57	563
C	21 4	M	148.8	0.50	555
C	26 4	M	263.5	0.86	555
C	27 4	M	196.6	0.67	555
C	38 4	M	230.0	0.77	534
C	39 4	M	197.5	0.69	534
C	60 4	C	208.7	0.71	555
C	62 4	C	185.8	0.63	555
D	1 4	S	241.5	0.83	555
D	5 4	S	240.0	0.84	555
D	12 4	S	242.7	0.82	555
D	20 4	M	207.4	0.69	563
D	21 4	M	131.8	0.43	555
D	26 4	M	197.3	0.64	555
D	27 4	M	169.0	0.57	555
D	38 4	M	219.0	0.74	534
D	39 4	M	168.5	0.59	534
D	60 4	C	141.3	0.48	555
D	62 4	C	194.1	0.67	555
E	1 4	S	242.2	0.85	555
E	5 4	S	179.0	0.62	555
E	12 4	S	280.5	0.96	555
E	20 4	M	250.5	0.83	563
E	21 4	M	152.0	0.52	555
E	26 4	M	230.0	0.79	555
E	27 4	M	154.3	0.53	555
E	38 4	M	241.0	0.82	534
E	39 4	M	178.0	0.61	534
E	60 4	C	202.8	0.70	555
E	62 4	C	141.5	0.49	555
H	1 4	S	280.4	0.94	555
H	5 4	S	219.5	0.76	555
H	12 4	S	192.8	0.67	555
H	20 4	M	263.0	0.89	563
H	21 4	M	186.5	0.64	555
H	26 4	M	246.5	0.82	555
H	27 4	M	145.1	0.49	555
H	38 4	M	233.4	0.78	534
H	39 4	M	187.5	0.64	534
H	60 4	C	197.3	0.67	555
H	62 4	C	211.7	0.73	555
I	1 4	S	239.5	0.83	555
I	5 4	S	229.8	0.81	555

BILLET SECTION	TEST NO.	SPECIMEN LOCATION	ULT STR KSI	N/S U.S. RATIO	BHN
I	12 4	S	280.2	0.94	555
I	20 4	M	222.0	0.77	563
I	21 4	M	148.5	0.52	555
I	26 4	M	205.5	0.66	555
I	27 4	M	189.4	0.64	555
I	38 4	M	244.5	0.83	543
I	39 4	M	197.8	0.69	534
I	60 4	C	147.7	0.50	555
I	62 4	C	216.0	0.73	555
J	1 4	S	254.3	0.89	555
J	5 4	S	242.0	0.85	555
J	12 4	S	168.3	0.58	555
J	20 4	M	210.0	0.69	563
J	21 4	M	154.8	0.52	555
J	26 4	M	203.0	0.66	555
J	27 4	M	172.8	0.58	555
J	38 4	M	144.2	0.49	534
J	39 4	M	210.8	0.74	534
J	60 4	C	167.0	0.58	555
J	62 4	C	174.8	0.59	555
K	1 4	S	240.5	0.85	555
K	5 4	S	254.0	0.87	555
K	12 4	S	272.0	0.93	555
K	20 4	M	231.5	0.77	563
K	21 4	M	153.0	0.52	555
K	26 4	M	228.5	0.74	534
K	27 4	M	173.4	0.59	555
K	38 4	M	213.0	0.72	534
K	39 4	M	182.1	0.63	534
K	60 4	C	198.2	0.68	555
K	62 4	C	179.8	0.61	555
L	1 4	S	282.3	1.00	555
L	5 4	S	230.5	0.90	555
L	12 4	S	162.8	0.58	555
L	20 4	M	232.7	0.81	563
L	21 4	M	195.0	0.68	555
L	26 4	M	287.0	0.94	534
L	27 4	M	207.3	0.69	555
L	38 4	M	213.0	0.72	534
L	39 4	M	277.0	0.93	534
L	60 4	C	166.0	0.58	555
L	62 4	C	168.0	0.57	555
M	1 4	S	187.5	0.64	555
M	5 4	S	235.5	0.84	555
M	12 4	S	229.4	0.80	555
M	20 4	M	134.0	0.47	563
M	21 4	M	241.5	0.79	555
M	26 4	M	232.5	0.76	534
M	27 4	M	164.5	0.56	555
M	38 4	M	209.9	0.71	534
M	39 4	M	278.5	0.95	534
M	60 4	C	152.8	0.52	555
M	62 4	C	194.0	0.65	555
N	1 4	S	243.5	0.85	555
N	5 4	S	251.5	0.85	555
N	12 4	S	264.5	0.90	555
N	20 4	M	210.0	0.70	563
N	21 4	M	183.5	0.64	555
N	26 4	M	210.5	0.68	534
N	27 4	M	213.4	0.74	555
N	38 4	M	214.5	0.73	534
N	39 4	M	113.2	0.39	534
N	60 4	C	181.3	0.63	555
N	62 4	C	181.2	0.65	555
P	1 4	S	233.5	0.79	555
P	5 4	S	261.7	0.95	555
P	12 4	S	242.2	0.81	555
P	20 4	M	223.4	0.77	563
P	21 4	M	191.0	0.65	555
P	26 4	M	261.5	0.85	534
P	27 4	M	213.0	0.73	555
P	38 4	M	228.2	0.78	534

BILLET SECTION	TEST NO.	SPECIMEN LOCATION	ULT STR KSI	N/S U.S. RATIO	BHN
P	39 4	M	255.5	0.88	534
P	60 4	C	178.5	0.61	555
P	62 4	C	172.4	0.59	555
S	1 4	S	261.6	0.90	555
S	5 4	S	257.5	0.91	555
S	12 4	S	243.9	0.82	555
S	20 4	M	233.5	0.79	563
S	21 4	M	189.0	0.66	555
S	26 4	M	270.5	0.88	534
S	27 4	M	167.5	0.56	555
S	38 4	M	148.0	0.50	534
S	39 4	M	227.0	0.77	534
S	60 4	C	168.6	0.57	555
S	62 4	C	236.0	0.81	555
T	1 4	S	239.0	0.82	555
T	5 4	S	249.0	0.86	555
T	12 4	S	257.5	0.91	555
T	20 4	M	202.5	0.67	563
T	21 4	M	120.2	0.41	555
T	26 4	M	265.0	0.88	534
T	27 4	M	177.0	0.59	555
T	38 4	M	248.0	0.84	543
T	39 4	M	202.2	0.70	534
T	60 4	C	189.3	0.64	555
T	62 4	C	206.5	0.78	555
V	1 4	S	219.2	0.77	555
V	5 4	S	254.0	0.87	555
V	12 4	S	194.1	0.66	555
V	20 4	M	205.3	0.71	563
V	21 4	M	140.0	0.47	555
V	26 4	M	231.5	0.79	534
V	27 4	M	172.7	0.60	555
V	38 4	M	239.5	0.81	534
V	39 4	M	215.5	0.75	534
V	60 4	C	176.3	0.60	555
V	62 4	C	192.8	0.65	555

SECTION 4

LONGITUDINAL NOTCHED TENSILE PROPERTIES OF
AIR MELT-DEGAS-VACUUM ARC REMELT H-11 STEEL
(HEAT NO. W-24342-V1)

LONGITUDINAL NOTCHED TENSILE PROPERTIES
OF AIR MELT-DEGAS-VACUUM ARC REMELT
H-11 STEEL HEAT NO. W-24942-V1

BILLET SECTION	TEST NO.	SPECIMEN LOCATION	ULT STR KSI	N/S U.S. RATIO	BHN
A	13 S	S	265.2	0.89	578
A	17 S	S	300.5	0.97	555
A	40 S	M	270.1	0.90	555
A	44 S	M	272.5	0.89	578
A	48 S	M	273.6	0.89	578
A	64 S	C	212.5	0.71	563
A	66 S	C	270.8	0.90	555
B	13 S	S	279.5	0.95	578
B	17 S	S	268.5	0.87	555
B	40 S	M	250.9	0.82	555
B	44 S	M	284.0	0.93	578
B	48 S	M	240.9	0.78	578
B	64 S	C	227.7	0.75	563
B	66 S	C	209.0	0.70	555
C	13 S	S	236.0	0.81	578
C	17 S	S	271.0	0.88	555
C	40 S	M	262.2	0.86	555
C	44 S	M	219.9	0.71	578
C	48 S	M	283.3	0.92	578
C	64 S	C	202.6	0.68	563
C	66 S	C	177.3	0.58	555
D	13 S	S	266.3	0.94	578
D	17 S	S	276.0	0.91	555
D	40 S	M	265.9	0.88	555
D	44 S	M	256.0	0.83	578
D	48 S	M			578
D	64 S	C	233.0	0.78	563
D	66 S	C	208.0	0.68	555
E	13 S	S	255.5	0.89	578
E	17 S	S	243.6	0.79	555
E	40 S	M	263.0	0.87	555
E	44 S	M	260.5	0.87	578
E	48 S	M	271.0	0.92	578
E	64 S	C	225.0	0.76	563
E	66 S	C	237.5	0.78	555
H	13 S	S	286.0	0.99	578
H	17 S	S	205.8	0.68	555
H	40 S	M	279.3	0.92	555
H	44 S	M	272.5	0.90	578
H	48 S	M	247.1	0.81	578
H	64 S	C	223.0	0.75	563
H	66 S	C	222.0	0.73	555
I	13 S	S	277.0	0.98	578
I	17 S	S	281.0	0.94	555
I	40 S	M	234.5	0.78	555
I	44 S	M	185.1	0.61	578
I	48 S	M	276.8	0.91	578
I	64 S	C	237.8	0.80	563
I	66 S	C	214.7	0.72	555
J	13 S	S	286.5	1.01	578
J	17 S	S	251.5	0.84	555
J	40 S	M	241.2	0.79	555
J	44 S	M	204.5	0.66	578
J	48 S	M	253.4	0.83	578
J	64 S	C	217.0	0.73	563
J	66 S	C	193.6	0.65	555
K	13 S	S	244.0	0.87	578
K	17 S	S	279.0	0.91	555
K	40 S	M	233.1	0.79	555
K	44 S	M	185.9	0.61	555
K	48 S	M	227.4	0.74	578
K	64 S	C	192.4	0.65	563
K	66 S	C	231.5		555
L	13 S	S	260.5	0.89	578
L	17 S	S	266.5	0.88	555

BILLET SECTION	TEST NO.	SPECIMEN LOCATION	ULT STR KSI	N/S U.S. RATIO	BHN
L	40 S	M	212.9	0.71	555
L	44 S	M	239.9	0.79	555
L	48 S	M	251.1	0.82	578
L	64 S	C	215.5	0.73	563
L	66 S	C	187.5	0.63	555
M	13 S	S	242.0	0.83	578
M	17 S	S	261.9	0.86	555
M	40 S	M	271.7	0.90	555
M	44 S	M	194.1	0.64	555
M	48 S	M	243.0	0.79	578
M	64 S	C	203.6	0.68	563
M	66 S	C	177.6		555
N	13 S	S	248.9	0.86	578
N	17 S	S	266.0	0.89	555
N	40 S	M	264.0	0.87	555
N	44 S	M	266.5	0.88	555
N	48 S	M	230.9	0.75	578
N	64 S	C	194.5	0.65	563
N	66 S	C	234.1	0.78	555
P	13 S	S	263.8	0.92	578
P	17 S	S	251.5	0.82	555
P	40 S	M	271.2	0.90	555
P	44 S	M	251.0	0.83	555
P	48 S	M	255.7	0.84	578
P	64 S	C			563
P	66 S	C	213.1	0.71	555
S	13 S	S	263.5	0.94	578
S	17 S	S	244.9	0.80	555
S	40 S	M	236.8	0.78	555
S	44 S	M	274.5	0.90	555
S	48 S	M	225.4	0.75	578
S	64 S	C	221.0	0.74	563
S	66 S	C	193.5	0.65	555
T	13 S	S	280.0	0.95	578
T	17 S	S	229.0	0.77	555
T	40 S	M	248.5	0.83	555
T	44 S	M	236.4	0.80	555
T	48 S	M	270.7	0.88	578
T	64 S	C	190.5	0.64	563
T	66 S	C	224.0	0.75	555
V	13 S	S	276.5	0.96	578
V	17 S	S	241.9	0.79	555
V	40 S	M	281.5	0.95	555
V	44 S	M	196.5	0.65	555
V	48 S	M	271.7	0.90	578
V	64 S	C	179.8	0.58	563
V	66 S	C	233.2	0.77	555

APPENDIX III

TENSILE PROPERTIES OF AIR MELT-DOUBLE VACUUM ARC REMELT H-11 STEEL (HEAT NO. W-24341-2)

SECTION 1

TRANSVERSE TENSILE PROPERTIES OF AIR MELT-DOUBLE VACUUM ARC REMELT H-11 STEEL (HEAT NO. W-24341-2)

TRANSVERSE TENSILE PROPERTIES
OF AIR MELT DOUBLE VACUUM ARC REMELT
H 11 STEEL HEAT NO. W 24341-2

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
A	02 4	S	223.0	295.0	4.0	11.1	555
A	03 4	S	236.5	300.5	3.0	5.9	555
A	04 4	S	223.9	300.6	6.0	12.8	555
A	06 4	S	227.3	295.0	1.5	3.9	555
A	07 4	S	227.5	297.8	6.0	13.4	555
A	08 4	S	230.0	290.9	3.5	5.1	534
A	09 4	S	230.0	296.3	4.5	8.5	534
A	10 4	S	233.1	299.9	5.5	5.9	555
A	11 4	S	231.1	295.1	1.0	1.6	534
A	22 4	M	228.8	300.0	2.5	4.7	555
A	23 4	M	235.6	293.8	.5	.8	555
A	24 4	M	225.3	293.8	3.3	5.4	534
A	25 4	M	230.0	296.3	2.5	5.4	534
A	28 4	M	221.5	292.5	3.0	5.0	555
A	29 4	M	226.0	279.0	2.0	3.9	555
A	30 4	M	230.8	293.8	2.5	6.2	555
A	31 4	M	240.0	301.3	3.0	5.8	534
A	32 4	M	217.0	247.0	.5	2.0	555
A	33 4	M	229.3	292.5	2.0	4.3	555
A	34 4	M	221.0	287.5	2.5	5.8	555
A	35 4	M	235.0	297.5	1.5	3.1	555
A	36 4	M		222.5	.5	1.1	555
A	37 4	M	239.0	284.3	1.5	2.3	555
A	61 4	C	227.0	285.0	1.5	3.1	555
A	63 4	C	233.0	275.8	1.0		555
B	02 4	S	215.8	292.5	3.0	4.7	555
B	03 4	S	231.2	282.0	2.0	2.4	555
B	04 4	S	233.3	298.8	3.0	5.4	555
B	06 4	S	232.5	305.0	4.5	7.7	555
B	07 4	S	229.8	294.3	1.8	4.7	555
B	08 4	S	233.7	296.1	2.5	3.2	534
B	09 4	S	221.5	289.5	4.5	8.5	534
B	10 4	S	228.5	296.2	5.3	10.1	555
B	11 4	S	230.5	293.2	6.5	5.9	534
B	22 4	M	233.3	302.5	3.5	7.0	555
B	23 4	M	231.5	293.0	2.0	3.9	555
B	24 4	M	223.3	292.5	3.3	5.6	534
B	25 4	M	231.8	302.5	2.0	4.7	555
B	28 4	M	222.2	288.7	1.5	3.5	555
B	29 4	M	235.8	296.4	2.0	2.8	555
B	30 4	M	224.3	277.0	.8	1.4	555
B	31 4	M	224.5	295.0	2.8	4.7	534
B	32 4	M	231.8	296.9	4.0	3.6	555
B	33 4	M	228.0	290.0	2.0	4.7	555
B	34 4	M	227.5	298.3	2.5	4.3	555
B	35 4	M	225.5	293.8	3.0	6.2	555
B	36 4	M	232.5	292.8	.5	1.9	555
B	37 4	M	228.5	289.4	2.0	3.6	555
B	61 4	C	226.5	291.3	2.0	3.9	555
B	63 4	C	225.8	290.0	1.5	2.7	555
C	02 4	S	220.1	298.5	3.0	6.3	555
C	03 4	S	241.2	302.0	3.5	7.0	555
C	04 4	S	223.0	280.0	1.0	2.0	555
C	06 4	S	227.5	253.3	.5	2.7	555
C	07 4	S	220.3	275.5	1.3	2.7	555
C	08 4	S	237.2	254.1	1.0	1.6	534
C	09 4	S	229.8	275.5	3.5	6.2	534
C	10 4	S	251.0	310.0	3.5	5.8	555
C	11 4	S	234.7	308.4	6.5	8.2	534
C	22 4	M	229.3	298.8	4.0	5.8	555
C	23 4	M	234.3	296.2	1.0	2.7	555
C	24 4	M	220.8	287.5	1.8	3.1	534
C	25 4	M	221.8	267.5	1.0	3.1	555
C	28 4	M	216.8	277.5	2.3	3.6	555
C	29 4	M	231.6	288.5	2.0	4.0	555
C	30 4	M	223.2	282.5	1.5	4.3	555
C	31 4	M	226.3	262.3	.5	1.9	534
C	32 4	M	216.9	266.0	1.5	2.0	555
C	33 4	M	224.5	283.8	2.5	3.1	555
C	34 4	M	214.4	277.3	2.0	3.6	555
C	35 4	M	229.5	296.3	2.5	4.3	555
C	36 4	M	221.0	289.3	4.0	5.0	555

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
C	37 4	M	240.5	291.2	1.5	3.2	555
C	61 4	C	228.5	249.8	.3	.8	555
C	63 4	C	225.8	292.5	2.0	4.3	555
D	02 4	S	217.8	263.2	2.5	4.7	555
D	03 4	S		188.5		.4	555
D	04 4	S	216.8	278.8	1.0	3.5	555
D	06 4	S	225.0	296.3	1.8	3.1	555
D	07 4	S	227.0	291.5	4.5	9.1	555
D	08 4	S	221.1	287.2	2.0	3.1	534
D	09 4	S	227.0	229.2	.5	2.0	534
D	10 4	S	226.5	272.0	1.5	2.7	555
D	11 4	S	225.0	283.2	2.0	4.3	534
D	22 4	M	228.0	276.3	1.5	4.7	555
D	23 4	M	234.0	303.8	2.5	3.9	555
D	24 4	M	221.5	285.5	2.9	3.9	534
D	25 4	M	226.3	298.8	2.0	3.9	555
D	28 4	M	228.5	270.0	1.0	1.9	555
D	29 4	M	241.9	300.4	2.0	2.4	555
D	30 4	M	230.3	301.3	2.5	3.9	555
D	31 4	M	228.3	287.5	2.8	5.4	534
D	32 4	M	220.5	285.4	2.5	5.5	555
D	33 4	M	227.1	291.0	4.5	4.4	555
D	34 4	M	224.9	291.2	2.0	3.9	555
D	35 4	M	223.0	288.1	4.5	6.7	555
D	36 4	M	223.5	289.0	1.5	3.5	555
D	37 4	M	232.1	294.9	1.5	4.0	555
D	61 4	C	230.5	301.0	2.5	5.0	555
D	63 4	C	230.5	297.3	1.5	1.6	555
E	02 4	S	217.0	289.6	2.5	4.8	555
E	03 4	S	233.5	297.3	3.5	7.7	555
E	04 4	S	225.3	297.0	4.0	5.1	555
E	06 4	S	227.3	295.8	3.0	5.9	555
E	07 4	S	227.5	293.3	2.0	3.1	555
E	08 4	S	226.0	291.3	2.0	4.4	534
E	09 4	S	225.0	295.5	3.2	6.2	534
E	10 4	S	229.5	295.8	2.0	3.1	555
E	11 4	S	227.1	299.3	5.5	9.3	534
E	22 4	M	235.0	296.3	1.5	3.5	555
E	23 4	M	239.0	293.5	1.0	1.1	555
E	24 4	M	220.8	287.5	1.8	3.9	534
E	25 4	M	231.2	299.0	2.5	3.4	534
E	28 4	M	229.3	297.5	2.5	4.7	555
E	29 4	M	236.5	288.0	1.5	1.9	555
E	30 4	M	228.5	295.0	2.8	4.3	555
E	31 4	M	231.5	297.3	3.0	5.0	534
E	32 4	M	230.0	281.8	2.0	2.7	555
E	33 4	M	235.1	298.9	3.0	2.0	555
E	34 4	M	224.5	296.1	3.0	2.8	555
E	35 4	M	237.0	283.8	1.0	1.9	555
E	36 4	M	231.5	306.3	3.0	3.9	555
E	37 4	M	238.6	290.0	1.0	.8	555
E	61 4	C	230.7	274.2	.8	2.8	555
E	63 4	C					555
H	02 4	S	220.5	292.5	2.5	3.9	555
H	03 4	S	235.5	294.0	2.0	5.1	555
H	04 4	S	221.3	288.8	1.5	4.7	555
H	06 4	S	227.5	290.0	2.0	3.5	555
H	07 4	S	224.5	289.5	2.0	4.3	555
H	08 4	S	229.5	283.4	2.0	4.7	534
H	09 4	S	221.0	284.8	1.8	4.4	534
H	10 4	S	230.5	292.3	1.5	3.5	555
H	11 4	S	231.9	284.9	1.0	3.2	534
H	22 4	M	231.3	296.3	2.0	3.9	555
H	23 4	M	235.0	290.3	2.5	8.9	555
H	24 4	M	231.8	300.0	2.3	3.9	534
H	25 4	M	235.3	298.8	1.5	3.1	534
H	28 4	M	234.5	298.8	2.3	3.9	555
H	29 4	M	234.5	299.0	3.5	4.3	555
H	30 4	M	233.5	305.0	3.0	3.9	555
H	31 4	M	234.2	269.3	.5	1.6	534
H	32 4	M	228.7	294.9	2.0	5.1	555
H	33 4	M	230.0	295.8	1.5	2.0	555
H	34 4	M	232.5	295.0	2.0	3.9	555
H	35 4	M	236.5	285.0	1.0	2.7	555
H	36 4	M	230.0	292.5	2.0	3.5	555

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI ,2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
H	37 4	M	234.8	278.8	1.0	4	555
H	61 4	C	227.5	288.0	2.0	1.1	555
H	63 4	C	228.0	282.5	1.5	1.1	555
I	02 4	S	215.5	290.0	2.0	5.0	555
I	03 4	S	228.5	287.1	2.5	3.2	555
I	04 4	S	221.8	275.0	1.0	3.1	555
I	06 4	S	229.9	295.8	1.5	3.6	555
I	07 4	S	232.3	296.3	1.5	3.5	555
I	08 4	S	232.1	297.5	3.0	4.0	534
I	09 4	S	227.0	266.0	.5	2.3	534
I	10 4	S	228.8	300.0	3.0	6.6	555
I	11 4	S	230.5	295.1	2.0	3.2	534
I	22 4	M	233.5	305.0	2.0	4.3	555
I	23 4	M	231.5	279.3	1.5	1.1	555
I	24 4	M	228.3	293.1	1.8	4.7	534
I	25 4	M	230.5	292.5	1.5	3.9	555
I	28 4	M	227.0	282.5	.8	2.3	555
I	29 4	M	246.1	297.2	1.5	3.6	555
I	30 4	M	231.0	297.5	1.8	4.3	555
I	31 4	M	229.2	291.3	2.0	3.6	534
I	32 4	M	230.9	287.1	1.5	2.8	555
I	33 4	M	236.6	285.9	1.5	1.2	555
I	34 4	M	227.0	308.8	5.0	7.3	555
I	35 4	M	245.0	301.3	2.0	2.3	555
I	36 4	M	236.0	310.0	2.0	3.1	555
I	37 4	M	228.0	288.0	1.5	2.4	555
I	61 4	C	230.5	300.0	2.5	4.7	555
I	63 4	C	209.5	282.5	2.5	5.0	555
J	02 4	S	222.5	278.9	1.5	3.2	555
J	03 4	S	227.5	267.0	1.0	2.3	555
J	04 4	S	227.3	277.8	1.0	2.7	555
J	06 4	S	233.3	297.5	1.5	3.1	555
J	07 4	S	232.3	285.5	1.0	3.9	555
J	08 4	S	227.0	292.4	2.0	5.1	534
J	09 4	S	230.5	280.0	1.0	3.1	534
J	10 4	S	232.0	298.0	2.5	4.3	555
J	11 4	S	234.0	296.0	3.0	5.5	534
J	22 4	M	235.0	297.5	1.5	4.3	555
J	23 4	M	239.1	307.1	2.0	2.4	555
J	24 4	M	224.5	295.0	2.5	5.0	534
J	25 4	M	228.3	298.8	3.0	4.7	555
J	28 4	M	226.7	285.1	1.5	3.5	555
J	29 4	M	230.0	282.8	1.0	3.1	555
J	30 4	M	223.8	281.8	1.5	2.3	555
J	31 4	M	229.3	287.0	1.8	3.9	534
J	32 4	M	221.6	283.3	2.0	5.9	555
J	33 4	M	226.0	261.8	.5	.4	555
J	34 4	M	225.0	292.5	2.5	3.5	555
J	35 4	M	215.5	283.8	3.2	5.4	555
J	36 4	M	234.0	307.5	2.0	3.1	555
J	37 4	M	224.5	277.0	1.5	3.1	555
J	61 4	C	223.1	279.8	1.3	4.4	555
J	63 4	C	228.0	298.8	2.0	4.7	555
K	02 4	S	222.5	285.8	1.0	2.3	555
K	03 4	S	224.0	295.0	2.5	6.2	555
K	04 4	S	230.0	291.7	2.0	3.9	555
K	06 4	S	228.8	292.0	1.8	4.4	555
K	07 4	S	235.3	301.2	1.8	2.8	555
K	08 4	S	232.1	302.4	3.8	6.6	534
K	09 4	S	228.3	286.5	1.0	1.9	534
K	10 4	S	228.5	294.0	2.0	3.9	578
K	11 4	S	227.0	292.5	2.0	5.4	555
K	22 4	M	233.5	303.8	2.5	5.0	578
K	23 4	M	230.0	286.5	2.0	2.3	555
K	24 4	M	223.3	283.8	1.0	2.8	555
K	25 4	M	225.0	295.0	1.8	5.0	555
K	28 4	M	233.5	276.3	.8	2.3	555
K	29 4	M	237.8	298.4	1.5	2.8	555
K	30 4	M	224.0	270.5	1.0	2.3	555
K	31 4	M	230.3	273.3	1.0	2.7	578
K	32 4	M	224.2	289.2	2.0	2.8	555
K	33 4	M	232.1	279.1	1.5	2.8	555
K	34 4	M	221.0	274.0	1.0	4.3	555
K	35 4	M	227.0	273.8	1.0	2.3	555
K	36 4	M	221.0	287.3	2.0	2.7	555

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
K	37 4	M	225.0	292.3	2.5	6.2	555
K	61 4	C	219.0	284.0	1.5	1.9	555
K	63 4	C	229.0	299.8	2.0	3.9	555
L	02 4	S	232.0	285.5	1.5	2.0	555
L	03 4	S	227.3	299.5	3.0	4.7	555
L	04 4	S	231.5	300.0	3.0	4.7	555
L	06 4	S	227.8	295.0	1.5	3.9	555
L	07 4	S	226.0	290.0	2.0	3.5	555
L	08 4	S	222.8	280.8	1.3	2.8	534
L	09 4	S	231.8	295.5	2.2	4.3	534
L	10 4	S	234.3	295.5	1.5	3.5	578
L	11 4	S	234.0	302.8	1.5	1.4	555
L	22 4	M	224.3	285.0	1.5	3.5	578
L	23 4	M	230.4	285.9	2.0	4.0	555
L	24 4	M	223.0	294.4	3.0	5.1	555
L	25 4	M	221.0	273.7	.5	2.3	555
L	28 4	M	225.5	264.3	.3	1.4	555
L	29 4	M	244.8	309.0	1.5	2.8	555
L	30 4	M	230.0	298.8	3.0	5.0	555
L	31 4	M	232.3	289.5	.8	2.7	578
L	32 4	M	221.5	285.8	2.0	3.2	555
L	33 4	M	229.6	287.1	1.5	2.0	555
L	34 4	M	222.2	280.6	1.5	3.0	555
L	35 4	M					555
L	36 4	M	226.0	287.3	2.0	3.1	555
L	37 4	M	275.0	292.0	2.5	4.7	555
L	61 4	C	228.5	297.5	2.0	3.1	555
L	63 4	C	237.1	300.8	2.5	3.2	555
M	02 4	S	221.8	295.0	2.8	5.0	555
M	03 4	S	222.8	277.5	.8	1.9	555
M	04 4	S	220.0	293.7	3.0	8.6	555
M	06 4	S	226.6	298.2	1.5	2.8	555
M	07 4	S	231.0	285.0	1.0	3.1	555
M	08 4	S	231.3	295.0	3.8	6.8	534
M	09 4	S	228.0	297.0	2.8	5.0	534
M	10 4	S	231.1	278.8	1.0	2.8	578
M	11 4	S	229.0	297.2	2.3	5.3	555
M	22 4	M	230.0	292.5	2.0	5.0	578
M	23 4	M	230.0	290.9	1.5	3.9	555
M	24 4	M	222.8	279.3	1.3	2.8	555
M	25 4	M	225.0	295.0	2.0	3.1	555
M	28 4	M	228.8	277.2	.8	2.4	555
M	29 4	M	241.8	292.9	1.5	2.4	555
M	30 4	M	230.7	297.1	2.5	5.5	555
M	31 4	M	224.5	288.1	3.0	5.5	578
M	32 4	M	236.1	309.6	2.0	4.4	555
M	33 4	M	236.8	287.2	1.0	4.0	555
M	34 4	M	236.6	307.1	2.5	4.0	555
M	35 4	M	235.3	288.8	1.5	2.3	555
M	36 4	M	232.5	295.0	1.0	3.9	555
M	37 4	M	239.0	295.5	2.0	1.4	555
M	61 4	C	230.8	293.0	1.5	3.1	555
M	63 4	C	233.0	298.8	2.5	3.5	555
N	02 4	S	225.0	306.3	2.0	5.4	555
N	03 4	S	229.1	294.3	1.5	2.5	555
N	04 4	S	223.3	291.6	2.0	4.3	555
N	06 4	S	226.8	298.8	3.0	5.8	555
N	07 4	S	227.3	299.3	2.5	3.9	555
N	08 4	S	228.0	293.1	1.8	3.6	534
N	09 4	S	224.0	276.5	.8	1.1	534
N	10 4	S	208.8	289.5	1.5	2.3	578
N	11 4	S	233.5	291.1	1.5	3.0	555
N	22 4	M	236.8	307.5	2.0	3.5	578
N	23 4	M	233.5	286.3	1.5	1.4	555
N	24 4	M	231.8	293.8	1.5	3.1	555
N	25 4	M	232.0	292.2	1.5	3.9	555
N	28 4	M	231.8	297.5	1.5	3.9	555
N	29 4	M	227.0	286.5	3.0	3.1	555
N	30 4	M	234.3	307.5	2.8	5.4	555
N	31 4	M	227.2	283.2	1.0	2.8	578
N	32 4	M	226.0	294.8	2.5	7.0	555
N	33 4	M	237.0	286.1	1.0	2.4	555
N	34 4	M	231.5	300.3	3.0	3.1	555
N	35 4	M	231.3	283.7	1.0	.7	555
N	36 4	M	231.5	303.8	3.0	5.0	555

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
N	37 4	M	231.5	288.8	2.0	3.1	555
N	61 4	C	224.8	282.3	1.0	1.9	555
N	63 4	C	227.5	295.9	3.5	4.4	555
P	02 4	S	220.5	267.5	.5	1.9	555
P	03 4	S	226.3	297.5	4.0	7.7	555
P	04 4	S	230.5	297.8	3.5	6.3	555
P	06 4	S	229.7	280.0	1.0	3.6	555
P	07 4	S	233.3	291.3	1.5	2.3	555
P	08 4	S	227.8	295.0	2.5	3.1	534
P	09 4	S	223.7	294.8	5.2	10.1	534
P	10 4	S	224.5	295.0	2.5	5.0	578
P	11 4	S	229.9	265.6	.8	1.2	555
P	22 4	M	234.0	295.0	2.0	4.7	578
P	23 4	M	277.5	289.5	2.0	5.4	555
P	24 4	M	227.3	289.5	1.5	4.3	555
P	25 4	M	235.5	302.5	2.8	4.3	555
P	28 4	M	229.0	295.0	1.8	2.3	555
P	29 4	M	237.5	295.5	3.5	4.7	555
P	30 4	M	225.3	287.5	1.8	2.7	555
P	31 4	M	234.8	299.3	2.3	3.1	578
P	32 4	M	230.5	296.5	2.0	3.1	555
P	33 4	M	230.5	287.1	1.5	2.4	555
P	34 4	M	226.8	291.3	1.0	2.7	555
P	35 4	M	228.9	292.4	1.5	2.3	555
P	36 4	M	228.5	296.0	2.5	4.7	555
P	37 4	M	230.5	297.5	3.0	5.0	555
P	61 4	C	223.7	287.5	1.5	2.4	555
P	63 4	C	223.5	284.0	1.5	2.3	555
S	02 4	S	227.0	298.8	2.0	3.5	555
S	03 4	S	227.0	275.0	.2	.8	555
S	04 4	S	226.3	300.2	3.5	7.4	555
S	06 4	S	226.5	289.3	2.0	4.4	555
S	07 4	S	226.0	296.0	3.0	5.3	555
S	08 4	S	228.0	295.7	2.5	4.4	534
S	09 4	S	228.3	280.0	1.0	3.5	534
S	10 4	S	236.5	305.0	3.5	6.6	578
S	11 4	S	232.3	302.5	2.5	3.9	555
S	22 4	M	231.5	300.1	2.5	4.7	578
S	23 4	M	231.0	271.5	1.5	1.9	555
S	24 4	M	230.8	295.0	2.2	3.5	555
S	25 4	M	227.8	297.5	2.0	4.3	555
S	28 4	M	236.4	308.1	4.3	6.7	555
S	29 4	M	237.0	285.6	2.0	1.5	555
S	30 4	M	233.3	301.3	1.5	2.7	555
S	31 4	M	233.3	284.8	1.5	3.9	578
S	32 4	M	229.0	286.6	2.0	4.7	555
S	33 4	M	235.0	302.9	3.0	5.5	555
S	34 4	M	229.8	298.8	4.0	7.3	555
S	35 4	M	236.3	304.6	2.0	5.1	555
S	36 4	M	228.5	298.3	2.5	7.0	555
S	37 4	M	234.3	296.8	2.3	3.5	555
S	61 4	C	219.0	252.5	1.0	1.9	555
S	63 4	C	225.5	293.8	2.0	1.4	555
T	02 4	S	219.8	300.0	2.5	4.3	555
T	03 4	S	227.3	292.5	1.0	1.9	555
T	04 4	S	225.0	290.0	2.0	3.9	555
T	06 4	S	233.8	302.2	4.0	7.0	555
T	07 4	S	232.8	303.8	6.0	13.0	555
T	08 4	S	230.8	296.3	2.0	4.3	534
T	09 4	S	227.5	294.5	1.5	1.9	534
T	10 4	S	236.5	292.5	1.0	.8	578
T	11 4	S	232.8	287.5	1.3	2.3	555
T	22 4	M	234.0	307.5	2.0	2.7	578
T	23 4	M	236.0	293.4	1.0		555
T	24 4	M	225.3	297.5	2.5	5.4	555
T	25 4	M	234.5	295.0	.5	.8	555
T	28 4	M	237.9	311.0	2.8	4.7	555
T	29 4	M	237.1	286.3	1.5	2.0	555
T	30 4	M	247.3	309.3	1.3	1.4	555
T	31 4	M	233.9	295.8	3.0	7.0	578
T	32 4	M	232.1	282.2	1.5	2.8	555
T	33 4	M	237.0	292.5	1.5	2.0	555
T	34 4	M	229.8	295.1	2.5	4.5	555
T	35 4	M	237.5	302.5	2.0	2.7	555
T	36 4	M	233.5	307.5	3.5	5.0	555

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
T	37 4	M	240.8	302.5	2.0	3.9	555
T	61 4	C	225.3	294.0	2.5	3.5	555
T	63 4	C	229.5	299.0	2.5	5.0	555
V	02 4	S	227.8	296.3	1.5	3.9	555
V	03 4	S	228.5	290.0	1.2	3.1	555
V	04 4	S	225.0	302.5	5.0	5.8	555
V	06 4	S	244.3	312.5	2.0	3.9	555
V	07 4	S	236.5	300.0	3.0	6.2	555
V	08 4	S	234.2	305.8	3.8	5.1	534
V	09 4	S	226.8	296.5	3.8	5.0	534
V	10 4	S	226.5	301.6	5.5	8.2	578
V	11 4	S	232.5	303.8	6.0	11.1	555
V	22 4	M	237.1	308.4	2.5	4.7	578
V	23 4	M	239.1	289.3	1.5	2.4	555
V	24 4	M	228.3	298.3	2.5	5.1	555
V	25 4	M	243.0	312.5	2.5	3.9	555
V	28 4	M	237.5	308.8	3.0	4.3	555
V	29 4	M	242.5	308.8	2.0	1.9	555
V	30 4	M	246.0	315.5	1.5	2.7	555
V	31 4	M	238.0	312.5	2.8	5.8	578
V	32 4	M	242.0	314.6	2.0	4.3	555
V	33 4	M	235.6	292.0	1.5	4.4	555
V	34 4	M	244.0	313.8	3.0	6.6	555
V	35 4	M	238.0	305.0	2.0	3.5	555
V	36 4	M	242.2	317.1	2.0	3.6	555
V	37 4	M	233.2	300.0	3.5	5.1	555
V	61 4	C	232.2	300.4	2.0	3.1	555
V	63 4	C	235.0	305.0	2.5	4.3	555

SECTION 2

LONGITUDINAL TENSILE PROPERTIES OF AIR MELT-DOUBLE VACUUM ARC REMELT H-11 STEEL (HEAT NO. W-24341-2)

LONGITUDINAL TENSILE PROPERTIES
OF AIR MELT-DOUBLE VACUUM ARC REMELT
H 11 STEEL HEAT NO. W 24341-2

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
A	14 S	S	224.3	292.5	2.0	3.5	555
A	15 S	S	220.2	293.2	3.5	6.7	555
A	16 S	S	221.6	294.1	4.0	5.5	555
A	18 S	S	233.6	305.9	5.5	10.8	555
A	41 S	M	232.5	302.8	3.0	4.3	555
A	42 S	M	227.5	306.3	4.0	6.2	534
A	43 S	M	237.0	296.5	4.5	9.2	555
A	45 S	M	224.3	297.5	4.2	9.6	555
A	46 S	M	224.8	302.0	5.0	7.8	555
A	47 S	M	230.8	306.3	3.0	4.7	534
A	49 S	M	226.0	303.0	2.0	5.5	555
A	50 S	M	227.5	298.4	6.0	14.6	555
A	51 S	M	236.5	307.5	3.2	4.7	578
A	65 S	C	229.0	307.5	4.5	7.8	555
A	67 S	C	232.0	300.0	2.0	4.7	534
B	14 S	S	233.3	306.3	5.5	8.9	555
B	15 S	S	216.3	296.3	6.2	12.6	555
B	16 S	S	220.5	296.0	6.0	9.6	555
B	18 S	S	232.8	304.8	4.5	5.8	555
B	41 S	M	231.1	293.1	4.0	10.1	555
B	42 S	M	228.7	296.1	5.0	8.2	534
B	43 S	M	232.0	295.5	4.5	10.7	555
B	45 S	M	222.1	295.9	4.5	8.6	555
B	46 S	M	223.3	301.0	5.5	10.4	555
B	47 S	M	224.8	297.5	4.0	8.1	534
B	49 S	M	226.5	295.0	2.0	3.9	555
B	50 S	M	224.0	292.0	5.5	12.7	555
B	51 S	M	221.9	293.1	4.2	9.7	578
B	65 S	C	232.5	298.3	3.5	5.0	555
B	67 S	C	225.0	294.0	3.0	4.4	534
C	14 S	S	235.0	308.8	2.5	5.0	555
C	15 S	S	231.3	292.5	1.0	1.1	555
C	16 S	S	229.7	302.0	5.3	11.6	555
C	18 S	S	229.5	302.5	3.5	3.5	555
C	41 S	M	229.5	297.0	4.5	9.3	555
C	42 S	M	223.3	287.5	2.0	3.9	534
C	43 S	M	238.1	308.1	5.5	10.4	555
C	45 S	M	225.5	306.3	4.0	7.0	555
C	46 S	M	218.8	290.0	4.0	6.6	555
C	47 S	M	225.5	305.0	5.5	11.1	534
C	49 S	M	225.5	300.0	5.0	9.6	555
C	50 S	M	220.8	288.1	2.8	4.7	555
C	51 S	M	221.8	298.8	6.5	13.4	578
C	65 S	C	237.0	308.8	4.5	10.0	555
C	67 S	C	235.8	302.5	4.8	10.0	534
D	14 S	S	226.0	293.8	2.0	4.7	555
D	15 S	S	220.7	287.1	1.8	2.0	555
D	16 S	S	221.3	287.5	3.0	6.2	555
D	18 S	S	228.5	291.1	2.0	5.9	555
D	41 S	M	225.5	298.5	4.0	6.6	555
D	42 S	M	230.5	295.0	4.5	9.2	534
D	43 S	M	234.4	303.2	3.8	5.8	534
D	45 S	M	233.4	306.5	4.0	6.8	555
D	46 S	M	225.0	301.0	5.5	10.8	555
D	47 S	M	234.2	305.7	2.8	4.0	534
D	49 S	M	227.0	304.0	2.0	5.5	555
D	50 S	M	220.3	295.0	2.8	5.0	555
D	51 S	M	224.3	300.0	3.2	5.4	578
D	65 S	C	226.0	296.0	4.0	7.3	555
D	67 S	C	225.0	295.0	4.0	8.5	534
E	14 S	S	230.0	297.4	6.5	13.0	555
E	15 S	S	217.1	303.2	7.2	18.5	555
E	16 S	S	226.0	302.1	6.8	10.4	555
E	18 S	S	227.9	301.0	6.5	13.1	555
E	41 S	M	235.5	307.5	3.0	5.0	555
E	42 S	M	232.0	301.3	5.0	6.2	534
E	43 S	M	236.5	310.9	3.2	5.1	534
E	45 S	M	231.0	300.0	4.0	7.3	555
E	46 S	M	234.4	310.9	5.5	7.0	555
E	47 S	M	232.5	307.2	2.5	5.9	534

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
E	49 5	M	228.5	313.8	3.5	5.0	555
E	50 5	M	222.0	296.3	4.2	7.7	555
E	51 5	M	237.9	307.1	3.5	4.7	578
E	65 5	C	231.5	298.3	2.5	5.4	555
E	67 5	C	235.5	305.0	4.0	7.0	534
H	14 5	S	231.0	297.5	5.0	8.5	555
H	15 5	S	218.5	298.8	7.0	11.9	555
H	16 5	S	221.3	299.0	4.0	6.5	555
H	18 5	S	230.5	296.5	7.5	13.0	555
H	41 5	M	237.1	308.5	2.5	4.7	555
H	42 5	M	230.8	310.0	3.5	6.2	534
H	43 5	M	232.1	309.7	3.5	4.7	555
H	45 5	M	230.8	299.5	1.0	4.0	555
H	46 5	M	238.6	309.2	4.5	8.5	555
H	47 5	M	234.3	302.5	2.0	3.9	534
H	49 5	M	226.3	306.3	2.5	5.0	555
H	50 5	M	231.0	308.2	5.0	8.5	555
H	51 5	M	231.8	305.0	2.5	4.3	578
H	65 5	C	235.9	296.3	2.0	4.7	555
H	67 5	C	232.0	295.8	1.8	4.7	534
I	14 5	S	229.3	298.8	3.5	7.7	555
I	15 5	S	220.3	297.1	5.5	9.3	555
I	16 5	S	225.9	298.2	4.5	7.0	555
I	18 5	S	228.0	301.3	5.5	9.3	555
I	41 5	M	234.6	286.0	1.5	2.4	555
I	42 5	M	230.8	311.3	4.5	9.2	534
I	43 5	M	236.8	297.5	1.5	3.5	534
I	45 5	M	230.5	303.8	2.2	3.1	555
I	46 5	M	235.5	308.1	3.5	6.5	555
I	47 5	M	230.1	305.7	2.0	4.4	534
I	49 5	M	227.5	303.8	2.0	3.1	555
I	50 5	M	230.3	301.3	7.5	17.7	555
I	51 5	M	230.4	303.4	2.2	4.4	578
I	65 5	C	236.0	292.5	1.5	3.9	555
I	67 5	C	224.8	297.5	2.3	2.7	534
J	14 5	S	230.0	305.0	4.5	7.3	555
J	15 5	S	223.2	300.8	5.5	9.7	555
J	16 5	S	218.5	299.5	3.0	5.5	555
J	18 5	S	228.4	301.8	3.0	5.1	555
J	41 5	M	218.5	285.0	2.5	7.0	555
J	42 5	M	230.8	298.8	5.5	11.5	534
J	43 5	M	228.5	291.3	3.0	4.7	534
J	45 5	M		235.7	.5	8	555
J	46 5	M	231.5	306.3	4.0	4.7	555
J	47 5	M	225.5	262.5	.5	1.9	534
J	49 5	M	218.0	293.2	4.0	10.8	555
J	50 5	M	221.5	292.5	2.8	5.8	555
J	51 5	M	218.2	288.2	2.5	5.9	578
J	65 5	C	212.5	279.0	4.0	8.9	555
J	67 5	C	213.3	270.0	2.5	5.0	534
K	14 5	S	224.0	291.3	2.0	4.7	578
K	15 5	S	225.3	287.5	1.5	2.7	578
K	16 5	S	233.2	293.8	1.8	3.4	555
K	18 5	S	229.5	296.8	3.5	6.7	555
K	41 5	M	228.5	299.5	4.5	8.6	555
K	42 5	M	224.9	283.0	1.5	3.2	555
K	43 5	M	232.2	294.2	3.5	4.4	555
K	45 5	M	236.3	310.0	3.0	4.7	555
K	46 5	M	227.4	293.5	3.5	4.7	555
K	47 5	M	230.8	298.8	4.0	6.6	555
K	49 5	M	222.0	282.1	1.5	3.2	555
K	50 5	M	215.0	273.8	1.0	2.7	555
K	51 5	M	224.3	283.8	1.0	3.9	555
K	65 5	C	233.8	302.5	8.0	11.5	578
K	67 5	C	226.4	299.9	5.5	8.5	555
L	14 5	S	224.1	283.0	1.5	4.4	578
L	15 5	S	222.3	296.3	4.5	8.1	578
L	16 5	S	221.8	296.3	5.2	7.0	555
L	18 5	S	229.5	298.8	3.0	5.4	555
L	41 5	M	230.0	304.5	4.0	6.3	555
L	42 5	M	222.5	296.3	7.0	14.8	555
L	43 5	M	238.1	308.3	5.5	8.9	555
L	45 5	M	232.5	307.5	3.2	4.3	555

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
L	46 5	M	233.1	299.0	4.5	7.4	555
L	47 5	M	227.3	307.5	4.0	8.1	555
L	49 5	M	229.0	309.5	6.0	9.3	555
L	50 5	M	223.3	305.0	5.0	9.6	555
L	51 5	M	229.3	300.0	6.0	14.5	555
L	65 5	C	239.3	309.7	4.0	6.6	578
L	67 5	C	230.8	305.0	3.8	6.6	534
M	14 5	S	226.3	296.3	5.0	9.2	578
M	15 5	S	225.0	298.8	6.5	6.6	578
M	16 5	S	227.2	299.3	7.3	19.3	555
M	18 5	S	231.0	288.6	2.0	3.2	555
M	41 5	M	233.1	307.1	3.0	5.9	555
M	42 5	M	229.8	300.0	7.5	17.4	555
M	43 5	M	232.5	305.0	4.0	7.7	555
M	45 5	M	230.0	301.8	2.5	4.4	555
M	46 5	M	233.0	303.5	7.0	11.2	555
M	47 5	M	234.0	302.0	3.5	4.7	555
M	49 5	M	226.3	303.8	3.5	6.6	555
M	50 5	M	226.8	297.1	7.0	14.9	555
M	51 5	M	233.5	307.5	2.8	5.4	555
M	65 5	C	231.3	301.0	5.0	9.3	578
M	67 5	C	231.0	296.6	3.0	3.9	555
N	14 5	S	231.8	305.0	5.0	8.1	578
N	15 5	S	222.3	301.3	4.8	9.6	578
N	16 5	S	225.3	303.8	5.5	12.6	555
N	18 5	S	233.2	300.4	7.0	18.5	555
N	41 5	M	230.7	299.4	2.5	6.3	555
N	42 5	M	237.5	307.5	6.5	13.4	555
N	43 5	M	233.2	298.1	1.8	3.5	555
N	45 5	M	228.5	294.5	2.0	3.9	555
N	46 5	M	234.8	309.4	5.5	12.3	555
N	47 5	M	224.5	297.5	3.5	5.4	555
N	49 5	M	222.5	300.8	4.0	7.0	555
N	50 5	M	227.5	301.0	3.5	6.7	555
N	51 5	M	225.0	293.8	1.5	1.9	555
N	65 5	C	235.0	301.3	2.5	3.9	578
N	67 5	C	223.5	296.3	3.5	6.2	534
P	14 5	S	230.0	302.5	5.0	7.0	578
P	15 5	S	222.5	301.3	5.5	10.4	578
P	16 5	S	225.3	302.2	6.8	15.3	555
P	18 5	S	227.5	301.5	5.5	8.6	555
P	41 5	M	231.0	303.2	2.0	4.0	555
P	42 5	M	226.4	310.0	5.0	7.7	555
P	43 5	M	238.5	306.3	2.5	4.3	555
P	45 5	M	231.4	300.9	5.5	2.4	555
P	46 5	M	227.1	312.1	5.5	10.8	555
P	47 5	M	227.0	302.5	5.0	10.7	555
P	49 5	M	229.0	306.5	6.5	13.0	555
P	50 5	M	225.5	303.8	3.5	3.5	555
P	51 5	M	231.9	304.5	6.5	18.2	555
P	65 5	C	231.3	303.3	6.0	9.3	578
P	67 5	C	225.5	294.0	5.8	11.9	534
S	14 5	S	227.0	300.0	6.0	8.9	578
S	15 5	S	223.5	300.0	2.2	4.7	578
S	16 5	S	223.7	304.0	5.0	4.4	555
S	18 5	S	235.7	304.5	6.5	14.5	555
S	41 5	M	235.0	313.3	3.5	5.9	555
S	42 5	M	230.0	303.3	3.0	3.6	555
S	43 5	M	234.5	303.8	4.0	5.8	555
S	45 5	M	231.7	301.8	4.5	5.1	555
S	46 5	M	235.8	308.3	3.5	5.9	555
S	47 5	M	233.8	302.5	2.2	5.8	555
S	49 5	M	225.0	292.5	1.5	2.7	555
S	50 5	M	228.2	303.3	4.0	7.8	555
S	51 5	M	225.8	297.5	3.5	6.6	555
S	65 5	C	228.8	297.5	3.5	5.8	578
S	67 5	C	227.5	291.5	4.0	7.4	555
T	14 5	S	230.0	302.5	8.0	15.9	578
T	15 5	S	225.3	302.5	8.5	24.1	578
T	16 5	S	228.3	303.8	8.0	18.1	555
T	18 5	S	233.0	301.5	5.0	11.9	555
T	41 5	M	232.1	308.9	3.0	6.7	555
T	42 5	M	233.5	302.5	7.0	19.2	555

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
T	43 5	M	240.5	308.0	3.5	5.8	555
T	45 5	M	231.0	306.3	4.0	6.2	555
T	46 5	M	236.1	312.0	4.5	10.0	555
T	47 5	M	237.5	309.4	3.5	7.0	555
T	49 5	M	234.2	315.8	4.0	5.9	555
T	50 5	M	229.5	303.3	4.8	10.5	555
T	51 5	M	237.3	315.9	2.8	4.0	555
T	65 5	C	236.3	307.3	4.5	7.0	578
T	67 5	C	228.0	297.8	3.5	4.9	555
V	14 5	S	236.0	307.5	7.5	15.2	578
V	15 5	S	223.3	297.5	8.5	22.0	578
V	16 5	S	226.0	300.9	7.3	18.5	555
V	18 5	S	233.0	300.0	7.5	20.2	555
V	41 5	M	235.1	308.1	4.0	8.6	555
V	42 5	M	242.0	318.8	5.0	6.2	555
V	43 5	M	235.0	306.3	4.5	11.9	555
V	45 5	M	219.3	297.5	6.0	16.3	555
V	46 5	M	243.6	322.0	4.5	8.2	555
V	47 5	M	229.3	302.5	3.5	6.2	555
V	49 5	M	231.0	316.3	7.0	12.6	555
V	50 5	M	236.0	317.2	4.5	10.1	555
V	51 5	M	236.8	315.0	3.5	6.2	555
V	65 5	C	245.0	315.0	4.5	8.9	578
V	67 5	C	231.3	301.2	2.8	4.7	534

SECTION 3

TRANSVERSE NOTCHED TENSILE PROPERTIES OF AIR MELT-DOUBLE VACUUM ARC REMELT H-11 STEEL (HEAT NO. W-24341-2)

TRANSVERSE NOTCHED TENSILE PROPERTIES
OF AIR MELT-DOUBLE VACUUM ARC REMELT
H-11 STEEL HEAT NO. W-24341-2

BILLET SECTION	TEST NO.	SPECIMEN LOCATION	ULT STR KSI	N/S U.S. RATIO	BHN
A	1 4	S		0.76	555
A	5 4	S	248.8	0.84	555
A	12 4	S	257.0	0.87	555
A	20 4	M	269.9	0.92	534
A	21 4	M	166.5	0.57	555
A	26 4	M	247.3	0.84	555
A	27 4	M	212.2	0.76	555
A	38 4	M	254.9	1.15	555
A	39 4	M	183.6	0.65	555
A	60 4	C	197.5	0.69	534
A	62 4	C	179.4	0.65	555
B	1 4	S	237.5	0.84	555
B	5 4	S	224.6	0.76	555
B	12 4	S	229.7	0.78	555
B	20 4	M	229.9	0.79	534
B	21 4	M	133.2	0.45	555
B	26 4	M	235.6	0.85	555
B	27 4	M	191.3	0.65	555
B	38 4	M	230.4	0.79	555
B	39 4	M	254.3	0.88	555
B	60 4	C	133.4	0.46	534
B	62 4	C	154.3	0.53	555
C	1 4	S	176.8	0.59	555
C	5 4	S	238.5	0.87	555
C	12 4	S	259.0	0.84	555
C	20 4	M	218.5	0.76	534
C	21 4	M	200.9	0.68	555
C	26 4	M	198.3	0.70	555
C	27 4	M	184.1	0.64	555
C	38 4	M	252.2	0.87	555
C	39 4	M	203.9	0.70	555
C	60 4	C	156.7	0.65	534
C	62 4	C	169.3	0.58	555
D	1 4	S	199.3	1.06	555
D	5 4	S	276.8	0.95	555
D	12 4	S	271.9	0.96	555
D	20 4	M	237.5	0.83	534
D	21 4	M	224.9	0.74	555
D	26 4	M	246.3	0.82	555
D	27 4	M	214.8	0.72	555
D	38 4	M	269.0	0.93	555
D	39 4	M	145.8	0.49	555
D	60 4	C	174.7	0.58	534
D	62 4	C	197.7	0.66	555
E	1 4	S	241.0	0.81	555
E	5 4	S	237.5	0.81	555
E	12 4	S	255.0	0.85	555
E	20 4	M	213.9	0.74	534
E	21 4	M	274.2	0.93	555
E	26 4	M	237.8	0.81	555
E	27 4	M	170.8	0.59	555
E	38 4	M	244.0	0.80	555
E	39 4	M	186.7	0.64	555
E	60 4	C	156.2	0.57	534
E	62 4	C	182.4		555
H	1 4	S	227.3	0.77	555
H	5 4	S	281.0	0.97	555
H	12 4	S	240.5	0.84	555
H	20 4	M	229.8	0.77	534
H	21 4	M	186.5	0.64	555
H	26 4	M	161.1	0.53	555
H	27 4	M	179.0	0.60	555
H	38 4	M	186.5	0.64	555
H	39 4	M	199.7	0.72	555
H	60 4	C	129.2	0.45	534
H	62 4	C	101.3	0.36	555
I	1 4	S	251.2	0.87	555
I	5 4	S	221.2	0.75	555

BILLET SECTION	TEST NO.	SPECIMEN LOCATION	ULT STR KSI	N/S U.S. RATIO	BHN
I	12 4	S	261.2	0.89	555
I	20 4	M	113.4	0.39	534
I	21 4	M	201.1	0.72	555
I	26 4	M	180.8	0.61	555
I	27 4	M	176.4	0.59	555
I	38 4	M	238.5	0.77	555
I	39 4	M	190.0	0.66	555
I	60 4	C	205.9	0.69	534
I	62 4	C	235.5	0.83	555
J	1 4	S	207.1	0.78	555
J	5 4	S	230.8	0.81	555
J	12 4	S	213.0	0.72	555
J	20 4	M	266.1	0.90	534
J	21 4	M	180.3	0.59	555
J	26 4	M	246.8	0.88	555
J	27 4	M	194.3	0.69	555
J	38 4	M	180.3	0.59	555
J	39 4	M	262.3	0.95	555
J	60 4	C	186.4	0.67	534
J	62 4	C	234.0	0.78	555
K	1 4	S	230.3	0.78	555
K	5 4	S	252.3	0.84	555
K	12 4	S	231.8	0.79	555
K	20 4	M	257.5	0.91	555
K	21 4	M	222.1	0.78	555
K	26 4	M	171.6	0.63	555
K	27 4	M	245.4	0.82	555
K	38 4	M	250.4	0.87	578
K	39 4	M	236.5	0.81	555
K	60 4	C	184.0	0.65	555
K	62 4	C	251.0	0.84	555
L	1 4	S	223.2	0.75	555
L	5 4	S	242.1	0.83	555
L	12 4	S	202.0	0.67	555
L	20 4	M	232.5	0.79	555
L	21 4	M	222.8	0.78	555
L	26 4	M	198.3	0.66	555
L	27 4	M	238.3	0.77	555
L	38 4	M	270.9	0.94	578
L	39 4	M	280.0	0.96	555
L	60 4	C	151.4	0.51	555
L	62 4	C	161.7	0.54	555
M	1 4	S	243.1	0.88	555
M	5 4	S	177.4	0.62	555
M	12 4	S	258.2	0.87	555
M	20 4	M	238.9	0.86	555
M	21 4	M	150.1	0.52	555
M	26 4	M	274.3	0.92	555
M	27 4	M	122.4	0.42	555
M	38 4	M	214.3	0.73	578
M	39 4	M	212.0	0.72	555
M	60 4	C	129.3	0.44	555
M	62 4	C	112.4	0.38	555
N	1 4	S	252.2	0.86	555
N	5 4	S	249.5	0.83	555
N	12 4	S	256.5	0.88	555
N	20 4	M	225.1	0.77	555
N	21 4	M	194.2	0.68	555
N	26 4	M	243.0	0.79	555
N	27 4	M	155.5	0.54	555
N	38 4	M	236.0	0.78	578
N	39 4	M	153.4	0.53	555
N	60 4	C	204.9	0.73	555
N	62 4	C	110.8	0.37	555
P	1 4	S	212.0	0.71	555
P	5 4	S	224.8	0.77	555
P	12 4	S	237.0	0.89	555
P	20 4	M	275.3	0.95	555
P	21 4	M	190.0	0.66	555
P	26 4	M	245.9	0.86	555
P	27 4	M	201.5	0.68	555
P	38 4	M	262.7	0.89	578

BILLET SECTION	TEST NO.	SPECIMEN LOCATION	ULT STR KSI	N/S U.S. RATIO	BHN
P	39 4	M	282.9	0.95	555
P	60 4	C	193.8	0.67	555
P	62 4	C	260.8	0.92	555
S	1 4	S	184.9	0.67	555
S	5 4	S	235.9	0.80	555
S	12 4	S	241.0	0.80	555
S	20 4	M	242.5	0.82	555
S	21 4	M	151.0	0.56	555
S	26 4	M	170.3	0.57	555
S	27 4	M	176.4	0.62	555
S	38 4	M	219.7	0.74	578
S	39 4	M	176.4	0.59	555
S	60 4	C	194.8	0.77	555
S	62 4	C	166.5	0.57	555
T	1 4	S	209.9	0.72	555
T	5 4	S	252.5	0.83	555
T	12 4	S	200.4	0.70	555
T	20 4	M	269.9	0.91	555
T	21 4	M	127.8	0.44	555
T	26 4	M	114.8	0.37	555
T	27 4	M	197.3	0.69	555
T	38 4	M	255.1	0.83	578
T	39 4	M	163.4	0.54	555
T	60 4	C	217.8	0.74	555
T	62 4	C	245.0	0.82	555
V	1 4	S	251.2	0.87	555
V	5 4	S	240.0	0.80	555
V	12 4	S	292.3	0.96	555
V	20 4	M	231.1	0.77	555
V	21 4	M	234.9	0.81	555
V	26 4	M	275.9	0.87	555
V	27 4	M	195.3	0.63	555
V	38 4	M	233.3	0.74	578
V	39 4	M	219.1	0.73	555
V	60 4	C	223.7	0.74	555
V	62 4	C	220.7	0.72	555

SECTION 4

LONGITUDINAL NOTCHED TENSILE PROPERTIES OF AIR MELT-DOUBLE VACUUM ARC REMELT H-11 STEEL (HEAT NO. W-24341-2)

LONGITUDINAL NOTCHED TENSILE PROPERTIES
OF AIR MELT-DOUBLE VACUUM ARC REMELT
H-11 STEEL HEAT NO. W-24341-2

BILLET SECTION	TEST NO.	SPECIMEN LOCATION	ULT STR KSI	N/S U.S. RATIO	BHN
A	13 S	S	264.9	1.10	555
A	17 S	S	290.1	0.95	534
A	40 S	M	243.5	0.80	534
A	44 S	M	254.8	0.84	555
A	48 S	M	248.2	0.83	534
A	64 S	C	230.1	0.75	563
A	66 S	C	225.8	0.75	555
B	13 S	S	271.5	0.89	555
B	17 S	S	253.2	0.83	534
B	40 S	M	256.6	0.87	534
B	44 S	M	246.2	0.82	555
B	48 S	M	262.3	0.90	534
B	64 S	C	186.6	0.63	563
B	66 S	C	182.9	0.62	555
C	13 S	S	227.2	0.74	555
C	17 S	S	239.4	0.79	534
C	40 S	M	202.8	0.71	534
C	44 S	M	293.3	1.01	555
C	48 S	M	277.3	0.96	534
C	64 S	C	242.0	0.78	563
C	66 S	C	252.6	0.84	555
D	13 S	S	262.6	0.89	555
D	17 S	S	218.6	0.75	534
D	40 S	M	253.4	0.86	534
D	44 S	M	251.3	0.83	555
D	48 S	M	283.1	0.96	534
D	64 S	C	220.0	0.74	563
D	66 S	C	224.8	0.76	555
E	13 S	S	231.0	0.78	555
E	17 S	S	287.3	0.95	534
E	40 S	M	235.5	0.78	534
E	44 S	M	239.8	0.77	555
E	48 S	M	249.0	0.84	534
E	64 S	C	268.1	0.89	563
E	66 S	C	229.1	0.75	555
H	13 S	S	265.6	0.89	555
H	17 S	S	217.0	0.73	534
H	40 S	M	241.1	0.78	534
H	44 S	M	238.0	0.77	555
H	48 S	M	260.5	0.85	534
H	64 S	C	162.1	0.55	563
H	66 S	C	259.1	0.88	555
I	13 S	S	266.1	0.89	555
I	17 S	S	288.0	0.96	534
I	40 S	M	261.0	0.84	534
I	44 S	M	276.4	0.90	555
I	48 S	M	289.7	0.96	534
I	64 S	C	224.8	0.77	563
I	66 S	C	207.3	0.70	555
J	13 S	S	245.0	0.80	555
J	17 S	S	222.2	0.74	534
J	40 S	M	257.5	0.86	534
J	44 S	M	238.9	0.78	555
J	48 S	M	275.2	0.94	534
J	64 S	C	233.8	0.84	563
J	66 S	C	188.3	0.70	555
K	13 S	S	212.1	0.73	555
K	17 S	S	272.5	0.92	555
K	40 S	M	239.9	0.85	555
K	44 S	M	267.5	0.91	555
K	48 S	M	276.5	1.01	555
K	64 S	C	262.4	0.87	563
K	66 S	C	266.7	0.89	555
L	13 S	S	232.9	0.82	555
L	17 S	S	293.0	0.98	555

BILLET SECTION	TEST NO.	SPECIMEN LOCATION	ULT STR KSI	N/S U.S. RATIO	BHN
L	40 S	M	251.9	0.85	555
L	44 S	M	279.6	0.94	555
L	48 S	M	267.3	0.88	555
L	64 S	C	222.8	0.72	563
L	66 S	C	237.5	0.78	555
M	13 S	S	253.3	0.86	555
M	17 S	S	254.5	0.88	555
M	40 S	M	250.2	0.83	555
M	44 S	M	243.7	0.80	555
M	48 S	M	284.8	0.96	555
M	64 S	C	213.8	0.71	563
M	66 S	C	231.2	0.78	555
N	13 S	S	238.0	0.78	555
N	17 S	S	272.8	0.91	555
N	40 S	M	153.3	0.50	555
N	44 S	M	276.4	0.89	555
N	48 S	M	237.8	0.79	555
N	64 S	C	232.8	0.77	563
N	66 S	C	266.9	0.90	555
P	13 S	S	259.9	0.86	555
P	17 S	S	296.3	0.98	555
P	40 S	M	240.0	0.77	555
P	44 S	M	300.7	0.96	555
P	48 S	M	235.3	0.77	555
P	64 S	C	241.3	0.80	563
P	66 S	C	231.7	0.79	555
S	13 S	S	250.1	0.83	555
S	17 S	S	257.2	0.84	555
S	40 S	M	288.6	0.95	555
S	44 S	M	278.0	0.90	555
S	48 S	M	252.3	0.83	555
S	64 S	C	289.5	0.97	563
S	66 S	C	262.7	0.90	555
T	13 S	S	244.1	0.81	555
T	17 S	S	280.0	0.93	555
T	40 S	M	231.9	0.77	555
T	44 S	M	243.4	0.78	555
T	48 S	M	226.5	0.75	555
T	64 S	C	257.0	0.84	563
T	66 S	C	259.1	0.87	555
V	13 S	S	274.8	0.89	555
V	17 S	S	282.9	0.94	555
V	40 S	M	246.6	0.77	555
V	44 S	M	262.1	0.81	555
V	48 S	M	271.6	0.86	555
V	64 S	C	213.7	0.68	563
V	66 S	C	242.3	0.80	555

APPENDIX IV

TENSILE PROPERTIES OF VACUUM INDUCTION MELT-VACUUM ARC REMELT H-11 STEEL (HEAT NO. W-24403-1)

SECTION 1

TRANSVERSE TENSILE PROPERTIES OF VACUUM INDUCTION MELT-VACUUM ARC REMELT H-11 STEEL (HEAT NO. W-24403-1)

TRANSVERSE TENSILE PROPERTIES
OF VACUUM INDUCTION MELT-VACUUM ARC REMELT
H 11 STEEL HEAT NO. W 24405-1

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
A	02 4	S	224.8	295.1	5.2	10.8	545
A	03 4	S	230.7	295.7	7.5	19.7	534
A	04 4	S	233.0	300.5	6.5	11.9	555
A	06 4	S	230.2	295.7	7.3	15.8	534
A	07 4	S	232.2	306.3	6.5	13.4	555
A	08 4	S	234.4	302.3	5.5	10.0	534
A	09 4	S	232.2	295.3	9.0	25.8	555
A	10 4	S	236.4	301.4	9.0	24.1	534
A	11 4	S	233.7	295.8	7.5	20.2	555
A	22 4	M	226.5	293.8	7.2	18.8	563
A	23 4	M	228.0	290.9	5.5	11.5	534
A	24 4	M	228.8	297.1	8.5	18.8	555
A	25 4	M	231.2	296.5	7.0	15.8	555
A	28 4	M	230.5	295.0	8.5	19.5	555
A	29 4	M	230.8	295.0	5.0	9.6	555
A	30 4	M	230.8	291.3	6.5	13.7	555
A	31 4	M	230.0	293.3	6.0	2.7	555
A	32 4	M	233.9	293.5	7.5	15.2	555
A	33 4	M	232.0	295.5	3.0	6.2	555
A	34 4	M	228.2	298.3	7.0	17.4	545
A	35 4	M	232.0	293.0	5.0	8.9	555
A	36 4	M	229.2	302.0	5.0	8.9	545
A	37 4	M	233.2	299.6	2.5	5.8	534
A	61 4	C	227.2	290.3	5.0	10.7	555
A	63 4	C	227.9	290.6	5.5	9.2	534
B	02 4	S	226.2	297.8	7.0	13.7	545
B	03 4	S	230.0	298.4	6.0	10.7	534
B	04 4	S	232.0	303.8	6.0	8.5	555
B	06 4	S	230.4	299.2	6.8	17.3	534
B	07 4	S	229.7	295.8	7.5	15.2	555
B	08 4	S	232.0	300.5	8.0	24.6	534
B	09 4	S	237.1	319.0	8.5	23.5	555
B	10 4	S	232.2	295.3	8.5	21.3	534
B	11 4	S	232.7	306.3	6.5	16.3	555
B	22 4	M	233.5	296.8	6.7	13.4	563
B	23 4	M	233.1	294.0	5.3	9.3	534
B	24 4	M	228.8	295.9	7.0	18.1	555
B	25 4	M	232.4	295.9	5.5	9.3	555
B	28 4	M	228.0	295.0	7.0	14.5	555
B	29 4	M	230.0	292.5	6.5	11.9	555
B	30 4	M	227.2	290.0	7.0	15.9	555
B	31 4	M	231.0	293.3	6.0	16.6	555
B	32 4	M	235.0	294.5	6.0	13.0	555
B	33 4	M	231.5	295.8	5.5	11.5	555
B	34 4	M	226.4	300.7	5.5	11.1	545
B	35 4	M	233.5	294.3	3.5	3.5	555
B	36 4	M	228.2	297.7	6.0	10.9	545
B	37 4	M	230.2	295.2	3.8	7.5	534
B	61 4	C	229.5	287.7	5.0	9.7	555
B	63 4	C	230.1	291.7	4.5	8.9	534
C	02 4	S	223.7	299.6	6.8	13.4	545
C	03 4	S	229.5	300.4	6.0	11.7	534
C	04 4	S	228.5	292.0	7.5	17.0	555
C	06 4	S	229.7	296.3	6.8	13.7	534
C	07 4	S	229.2	296.8	8.5	10.0	555
C	08 4	S	233.4	295.2	7.5	22.2	534
C	09 4	S	230.7	296.1	6.0	13.4	555
C	10 4	S	231.4	297.8	7.8	19.2	534
C	11 4	S	242.6	293.6	6.5	17.0	555
C	22 4	M	233.5	295.3	6.7	17.7	563
C	23 4	M	229.7	291.3	5.0	8.5	534
C	24 4	M	228.8	297.1	6.5	13.3	555
C	25 4	M	232.7	302.8	6.5	11.7	555
C	28 4	M	231.0	296.0	5.5	11.8	555
C	29 4	M	230.5	293.8	5.0	8.5	555
C	30 4	M	231.0	296.3	6.0	11.9	555
C	31 4	M	232.5	296.3	6.0	10.4	555
C	32 4	M	230.0	295.5	6.0	11.1	555
C	33 4	M	230.0	293.0	4.0	5.8	555
C	34 4	M	225.9	298.3	3.2	7.0	545
C	35 4	M	228.0	289.8	4.0	9.7	555
C	36 4	M	230.7	295.9	6.5	13.0	545

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
C	37 4	M	225.1	297.7	5.5	8.3	534
C	61 4	C	229.2	290.3	5.0	6.6	555
C	63 4	C	225.5	289.0	4.5	12.0	534
D	02 4	S	220.7	293.3	6.5	15.6	545
D	03 4	S	222.2	303.5	7.8	17.0	534
D	04 4	S	227.5	294.5	8.0	18.4	555
D	06 4	S	227.4	297.9	8.3	20.8	534
D	07 4	S	234.2	300.3	7.5	18.8	555
D	08 4	S	237.4	304.3	7.3	19.0	534
D	09 4	S	229.7	297.3	8.0	5.0	555
D	10 4	S	222.2	294.6	5.0	7.7	534
D	11 4	S	232.2	296.8	6.0	8.1	555
D	22 4	M	234.8	298.3	6.0	13.4	563
D	23 4	M	228.5	289.4	4.5	7.4	534
D	24 4	M	226.5	289.7	7.5	17.0	555
D	25 4	M	232.9	299.0	7.0	17.9	555
D	28 4	M	237.0	298.3	4.0	8.2	555
D	29 4	M	232.5	296.3	3.5	6.6	555
D	30 4	M	234.2	295.0	5.0	9.3	555
D	31 4	M	228.5	290.0	6.0	13.0	555
D	32 4	M	237.0	298.8	6.0	13.0	555
D	33 4	M	223.1	284.9	5.0	11.8	563
D	34 4	M	227.7	298.3	6.5	14.1	545
D	35 4	M	228.5	289.3	6.5	14.1	555
D	36 4	M	230.0	299.0	4.2	9.1	545
D	37 4	M	231.0	295.9	3.5	7.4	534
D	61 4	C	227.1	289.5	6.0	13.1	555
D	63 4	C	224.7	288.3	3.8	7.0	534
E	02 4	S	230.9	294.6	7.5	19.5	545
E	03 4	S	224.9	294.6	7.5	20.9	534
E	04 4	S	230.0	294.5	5.5	8.1	555
E	06 4	S	229.4	295.1	5.0	7.7	534
E	07 4	S	229.7	294.8	7.0	15.9	555
E	08 4	S	231.0	297.7	7.5	18.3	534
E	09 4	S	230.7	293.3	5.5	8.1	555
E	10 4	S	226.2	293.8	7.0	15.9	534
E	11 4	S	229.7	295.3	6.5	14.8	555
E	22 4	M	234.5	298.8	6.5	11.9	563
E	23 4	M	228.2	292.3	3.0	3.1	534
E	24 4	M	229.8	295.9	5.5	8.9	555
E	25 4	M	230.4	293.9	7.5	17.6	555
E	28 4	M	232.6	299.8	7.0	17.0	555
E	29 4	M	231.3	293.8	2.5	3.5	555
E	30 4	M	233.3	296.3	6.5	17.4	555
E	31 4	M	230.5	295.8	4.0	8.1	555
E	32 4	M	238.5	299.0	7.5	15.6	555
E	33 4	M	232.5	293.3	4.7	9.2	563
E	34 4	M	226.9	297.1	7.0	16.3	545
E	35 4	M	227.6	290.0	2.5	4.0	555
E	36 4	M	229.5	301.4	3.0	5.2	545
E	37 4	M	226.0	295.2	3.5	7.8	534
E	61 4	C	225.2	290.1	5.0	8.1	555
E	63 4	C	224.3	283.5	1.5	3.9	534
H	02 4	S	225.2	290.1	7.5	18.8	545
H	03 4	S	222.2	294.6	6.0	14.5	534
H	04 4	S	227.5	291.8	8.0	21.6	555
H	06 4	S	226.6	297.9	7.5	20.7	534
H	07 4	S	226.6	295.0	6.5	6.3	555
H	08 4	S	230.0	304.3	5.5	13.9	534
H	09 4	S	227.2	257.1	1.0	1.4	555
H	10 4	S	224.2	283.3	2.0	2.7	534
H	11 4	S	225.7	267.4	1.0	3.5	555
H	22 4	M	234.3	297.5	6.7	13.4	563
H	23 4	M	227.2	289.3	5.0	6.6	534
H	24 4	M	232.2	299.6	4.5	6.2	555
H	25 4	M	235.2	303.5	7.5	19.6	555
H	28 4	M	233.0	299.3	6.5	13.4	555
H	29 4	M	232.0	298.8	5.0	7.6	555
H	30 4	M	233.3	293.8	6.5	18.1	555
H	31 4	M	226.0	290.0	5.5	14.5	555
H	32 4	M	236.8	298.3	5.5	9.6	555
H	33 4	M	233.5	298.0	5.5	10.4	563
H	34 4	M	233.1	301.4	7.0	19.7	545
H	35 4	M	234.0	294.5	6.0	11.5	555
H	36 4	M	228.2	290.3	7.5	20.2	555

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
H	37 4	M	228.9	296.4	3.0	4.9	555
H	61 4	C	227.2	290.3	4.5	6.2	555
H	63 4	C	224.6	286.2	4.0	4.3	534
I	02 4	S	225.4	289.6	8.2	20.6	545
I	03 4	S	219.9	300.9	6.5	13.4	534
I	04 4	S	227.5	291.5	3.0	3.9	555
I	06 4	S	228.6	300.5	6.5	19.2	534
I	07 4	S	228.7	294.3	6.5	10.7	555
I	08 4	S	231.2	296.5	6.5	18.3	534
I	09 4	S	222.2	286.3	2.0	3.5	555
I	10 4	S	222.2	291.1	7.5	15.2	534
I	11 4	S	226.7	290.8	4.0	6.2	555
I	22 4	M	231.2	280.7	7.0	17.4	563
I	23 4	M	229.0	287.4	5.0	6.6	534
I	24 4	M	224.7	290.6	6.5	11.9	534
I	25 4	M	231.2	290.8	7.5	19.9	555
I	28 4	M	234.8	300.0	5.5	9.6	555
I	29 4	M	235.5	295.0	5.0	10.4	555
I	30 4	M	234.0	293.8	6.5	16.6	555
I	31 4	M	231.5	293.0	6.5	8.9	555
I	32 4	M	237.5	307.5	6.5	14.8	555
I	33 4	M	234.5	300.0	6.0	13.4	563
I	34 4	M	229.6	301.4	5.5	14.6	545
I	35 4	M	233.5	295.1	5.5	9.3	555
I	36 4	M	232.2	301.4	5.5	10.1	545
I	37 4	M	230.2	296.5	5.5	13.2	534
I	61 4	C	228.2	289.3	2.5	4.3	555
I	63 4	C	228.7	292.1	2.5	3.5	534
J	02 4	S	225.2	296.1	8.0	17.7	545
J	03 4	S	223.5	295.5	4.5	8.6	534
J	04 4	S	235.0	297.3	7.0	18.4	555
J	06 4	S	229.9	295.3	6.0	12.2	534
J	07 4	S	230.7	298.8	6.0	13.0	555
J	08 4	S	228.0	296.5	6.8	17.9	534
J	09 4	S	230.6	293.2	6.0	8.9	555
J	10 4	S	223.9	289.3	4.5	7.0	534
J	11 4	S	226.2	290.8	6.0	10.4	555
J	22 4	M	229.6	292.0	5.5	10.1	563
J	23 4	M	234.7	294.6	6.5	12.6	534
J	24 4	M	229.9	299.6	6.0	11.1	555
J	25 4	M	233.7	299.6	7.0	14.4	555
J	28 4	M	231.8	300.0	5.0	9.6	555
J	29 4	M	231.0	296.3	4.0	7.3	555
J	30 4	M	228.3	292.5	6.5	15.2	555
J	31 4	M	228.0	292.3	6.0	11.5	555
J	32 4	M	236.0	296.3	6.0	14.9	555
J	33 4	M	232.3	295.0	5.5	13.0	563
J	34 4	M	228.8	300.6	6.7	17.8	545
J	35 4	M	230.0	291.5	7.0	15.9	555
J	36 4	M	231.6	298.2	7.2	17.1	545
J	37 4	M	230.2	299.6	5.3	10.7	534
J	61 4	C	230.2	285.6	7.5	5.0	555
J	63 4	C	232.7	290.3	3.0	3.9	534
K	02 4	S	222.7	290.1	5.8	11.9	528
K	03 4	S	224.7	303.4	8.0	23.0	534
K	04 4	S	225.0	292.8	3.5	5.8	555
K	06 4	S	227.8	291.2	5.0	9.6	534
K	07 4	S	231.1	296.5	3.5	7.4	534
K	08 4	S	227.8	290.7	5.3	10.8	534
K	09 4	S	229.6	293.1	4.5	4.3	555
K	10 4	S	226.3	288.4	6.0	12.2	534
K	11 4	S	232.2	293.3	5.0	9.6	555
K	22 4	M	228.3	289.9	7.5	18.9	545
K	23 4	M	227.7	294.6	5.0	7.7	534
K	24 4	M	227.3	293.4	7.0	16.3	555
K	25 4	M	233.2	295.1	6.5	14.8	555
K	28 4	M	227.5	293.8	6.0	14.1	534
K	29 4	M	227.7	292.2	6.0	9.3	555
K	30 4	M	232.2	295.5		15.2	555
K	31 4	M	231.0	291.8	7.5	14.8	555
K	32 4	M	235.0	295.8	5.5	16.3	555
K	33 4	M	233.0	298.2	5.5	14.5	545
K	34 4	M	224.5	295.1	6.5	15.7	528
K	35 4	M	230.5	289.8	4.0	5.9	555
K	36 4	M	227.8	296.3	6.8	15.4	534

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
K	37 4	M	231.9	299.6	4.5	9.2	555
K	61 4	C	229.2	292.3	4.0	5.8	555
K	63 4	C	228.9	292.6	5.5	12.2	534
L	02 4	S	224.4	289.8	6.2	13.7	528
L	03 4	S	220.4	319.7	5.5	9.6	534
L	04 4	S	228.0	294.8	7.5	8.1	555
L	06 4	S	225.2	295.3	4.0	8.1	534
L	07 4	S	228.4	292.6	7.0	20.9	534
L	08 4	S	224.0	293.4	7.0	15.5	534
L	09 4	S	229.2	295.6	7.5	18.1	555
L	10 4	S	229.0	292.1	6.3	16.0	534
L	11 4	S	226.7	290.6	2.5	3.1	555
L	22 4	M	232.6	292.6	6.2	13.7	545
L	23 4	M	229.2	295.1	6.0	10.4	534
L	24 4	M	225.0	289.7	7.0	16.6	555
L	25 4	M	229.2	292.1	6.5	19.2	555
L	28 4	M	227.5	292.5	6.5	15.2	534
L	29 4	M	232.0	292.5	6.5	14.1	555
L	30 4	M	226.0	288.3	5.5	12.2	555
L	31 4	M	230.5	293.8	7.0	16.3	555
L	32 4	M	234.5	297.5	7.5	11.1	555
L	33 4	M	228.0	296.3	6.0	14.5	545
L	34 4	M	225.6	292.7	7.2	20.2	528
L	35 4	M	238.5	289.5	7.0	14.1	555
L	36 4	M	227.3	295.9	8.0	18.8	534
L	37 4	M	230.2	297.7	6.0	13.6	555
L	61 4	C	228.2	291.3	5.0	7.7	555
L	63 4	C	226.9	291.6	5.3	9.2	534
M	02 4	S	222.4	289.1	7.0	20.2	528
M	03 4	S	220.9	298.3	5.3	9.6	534
M	04 4	S	229.5	290.0	3.0	5.8	555
M	06 4	S	223.2	295.6	6.0	11.5	534
M	07 4	S	233.8	295.7	7.5	13.4	534
M	08 4	S	229.1	293.5	6.3	14.6	534
M	09 4	S	229.7	295.3	6.0	22.3	555
M	10 4	S	228.2	293.8	7.5	15.2	534
M	11 4	S	225.7	293.3	8.5	14.1	555
M	22 4	M	231.5	291.0	7.0	17.4	545
M	23 4	M	224.0	287.2	6.5	11.8	534
M	24 4	M	224.7	289.6	6.5	17.4	555
M	25 4	M	230.7	291.1	7.5	18.1	555
M	28 4	M	232.5	295.8	6.0	14.2	534
M	29 4	M	230.0	290.8	5.5	10.7	555
M	30 4	M	230.5	289.3	7.0	16.7	555
M	31 4	M	229.0	290.3	6.5	13.4	555
M	32 4	M	230.0	291.3	5.0	10.0	555
M	33 4	M	231.0	296.3	4.2	6.6	545
M	34 4	M	226.9	300.2	4.5	9.0	528
M	35 4	M	231.9	293.1	5.5	8.9	555
M	36 4	M	224.5	295.2	6.5	14.3	534
M	37 4	M	228.7	295.8	6.0	12.6	555
M	61 4	C	230.7	293.3	5.5	11.5	555
M	63 4	C	230.6	289.5	5.5	13.4	534
N	02 4	S	222.4	284.3	6.8	15.5	528
N	03 4	S	223.9	299.6	8.0	19.9	534
N	04 4	S	224.0	285.5	4.0	5.0	555
N	06 4	S	228.2	290.6	7.5	17.7	534
N	07 4	S	227.9	291.3	7.8	19.9	534
N	08 4	S	227.2	295.8	6.8	17.0	534
N	09 4	S	229.2	290.1	3.5	4.7	555
N	10 4	S	221.8	274.9	1.5	2.7	534
N	11 4	S	227.6	296.4	3.5	6.4	555
N	22 4	M	226.8	293.8	7.5	17.7	555
N	23 4	M	227.2	288.4	6.0	10.8	534
N	24 4	M	222.9	287.6	6.0	16.6	534
N	25 4	M	235.2	295.6	7.0	18.1	555
N	28 4	M	225.5	291.3	6.5	16.3	534
N	29 4	M	226.5	291.3	5.5	10.4	555
N	30 4	M	227.5	287.5	7.5	19.2	555
N	31 4	M	229.9	292.9	5.0	10.6	555
N	32 4	M	235.0	294.5	7.5	14.1	555
N	33 4	M	230.0	294.0	5.2	10.4	545
N	34 4	M	233.1	291.4	6.0	12.0	528
N	35 4	M	231.0	292.3	6.0	5.0	555
N	36 4	M	231.7	294.4	6.5	14.5	534

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
N	37 4	M	228.5	296.5	5.0	8.3	555
N	61 4	C	227.7	289.6	6.0	11.9	555
N	63 4	C	227.8	291.7	6.0	11.6	534
P	02 4	S	221.8	291.2	2.5	4.0	528
P	03 4	S	220.3	292.9	6.5	12.8	534
P	04 4	S	224.5	285.0	6.5	12.6	555
P	06 4	S	224.1	291.9	3.0	6.9	534
P	07 4	S	228.1	288.5	8.0	15.6	534
P	08 4	S	221.5	289.0	4.5	10.2	534
P	09 4	S	226.7	290.6	6.0	13.7	555
P	10 4	S	227.5	289.3	6.5	15.8	534
P	11 4	S	223.9	278.3	5.5	13.4	555
P	22 4	M	231.8	290.0	7.0	18.1	555
P	23 4	M	230.9	294.6	6.5	12.2	534
P	24 4	M	226.8	294.6	6.5	15.2	555
P	25 4	M	230.2	296.1	7.0	18.8	555
P	28 4	M	229.7	293.2	6.5	11.9	534
P	29 4	M	230.0	289.3	5.0	11.5	555
P	30 4	M	230.0	291.3	6.5	16.6	555
P	31 4	M	224.0	293.5	7.0	16.6	555
P	32 4	M	237.0	296.8	6.5	13.4	555
P	33 4	M	230.3	290.5	5.2	12.6	545
P	34 4	M	226.6	292.6	6.2	12.8	528
P	35 4	M	230.5	292.8	7.0	12.6	555
P	36 4	M	228.0	297.7	7.0	13.9	534
P	37 4	M	225.9	297.7	6.0	11.4	555
P	61 4	C	229.7	291.8	6.5	8.9	555
P	63 4	C	227.2	290.3	5.5	10.4	534
S	02 4	S	224.6	290.5	7.8	18.9	528
S	03 4	S	218.2	290.8	5.0	10.7	534
S	04 4	S	225.4	293.6	7.8	18.4	545
S	06 4	S	222.7	292.1	6.3	14.8	534
S	07 4	S	232.1	291.5	3.5	5.5	534
S	08 4	S	229.5	296.5	6.5	15.4	534
S	09 4	S	227.6	292.0	8.0	20.3	555
S	10 4	S	224.7	286.1	7.0	17.4	534
S	11 4	S	221.0	284.0	5.3	10.9	555
S	22 4	M	229.7	293.2	7.0	16.0	555
S	23 4	M	229.8	297.0	6.5	12.7	555
S	24 4	M	223.4	287.8	5.5	13.4	534
S	25 4	M	227.7	291.8	7.0	12.2	555
S	28 4	M	228.0	293.8	6.5	13.4	534
S	29 4	M	231.0	290.5	7.0	15.6	555
S	30 4	M	230.5	291.3	7.0	19.2	555
S	31 4	M	227.0	287.3	7.5	18.1	555
S	32 4	M	235.0	295.3	7.5	17.7	555
S	33 4	M	231.5	295.5	5.2	6.6	545
S	34 4	M	222.6	291.4	5.0	9.8	528
S	35 4	M	231.5	294.9	6.0	14.9	555
S	36 4	M	227.2	298.3	7.5	17.0	534
S	37 4	M	228.8	298.4	6.8	14.8	555
S	61 4	C	228.7	291.1	6.5	12.6	555
S	63 4	C	227.2	291.8	6.0	14.1	534
T	02 4	S	220.7	293.6	5.5	7.3	528
T	03 4	S	223.9	289.4	5.5	8.6	534
T	04 4	S	219.4	280.3	5.5	9.2	545
T	06 4	S	222.6	293.2	7.3	15.1	534
T	07 4	S	228.3	295.2	7.0	13.8	534
T	08 4	S	229.2	292.7	4.3	7.5	534
T	09 4	S	225.7	292.6	5.0	10.4	555
T	10 4	S	221.1	285.4	3.0	5.8	534
T	11 4	S	217.8	286.5	5.8	12.0	555
T	22 4	M	229.8	291.3	7.0	18.1	555
T	23 4	M	230.5	294.6	7.5	14.4	555
T	24 4	M	222.2	285.8	6.5	12.2	534
T	25 4	M	224.4	288.4	7.0	16.8	555
T	28 4	M	227.9	290.7	7.5	17.4	534
T	29 4	M	226.0	283.8	7.0	13.4	555
T	30 4	M	230.8	295.0	7.0	18.1	555
T	31 4	M	232.0	293.0	7.0	17.0	555
T	32 4	M	234.1	293.1	6.5	16.3	555
T	33 4	M	228.2	292.1	5.8	13.7	545
T	34 4	M	223.2	290.8	5.2	12.2	528
T	35 4	M	228.0	286.3	7.5	15.9	555
T	36 4	M	229.2	299.6	7.5	17.4	534

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
T	37 4	M	232.0	298.4	7.0	16.6	555
T	61 4	C	229.2	291.3	6.5	15.2	555
T	63 4	C	225.2	290.1	6.5	14.1	534
V	02 4	S	221.4	289.6	8.0	21.6	528
V	03 4	S	221.2	292.1	7.0	19.2	534
V	04 4	S	223.2	288.6	7.5	19.2	545
V	06 4	S	226.8	294.7	8.5	21.0	534
V	07 4	S	230.8	296.2	8.3	20.3	534
V	08 4	S	232.5	292.2	8.0	23.5	534
V	09 4	S	226.2	290.1	4.0	7.0	555
V	10 4	S	225.9	292.8	7.5	12.2	544
V	11 4	S	230.0	292.7	5.8	12.0	555
V	22 4	M	233.4	293.3	7.0	17.4	555
V	23 4	M	227.8	293.4	7.0	14.4	555
V	24 4	M	229.8	297.1	7.0	17.4	555
V	25 4	M	228.7	292.6	7.0	16.6	555
V	28 4	M	225.7	290.7	7.0	17.1	534
V	29 4	M	235.0	291.0	7.0	15.6	555
V	30 4	M	230.5	290.0	7.0	17.4	555
V	31 4	M	230.0	292.8	8.0	17.4	555
V	32 4	M	233.5	291.5	6.5	16.3	555
V	33 4	M	232.0	293.3	3.5	7.0	545
V	34 4	M	225.6	296.4	6.0	13.2	528
V	35 4	M	236.0	292.0	6.5	15.2	555
V	36 4	M	226.2	292.7	6.0	13.9	534
V	37 4	M	229.5	296.5	6.0	11.9	555
V	61 4	C	231.7	291.6	6.5	13.0	555
V	63 4	C	226.6	294.2	5.8	13.0	534

SECTION 2

LONGITUDINAL TENSILE PROPERTIES OF
VACUUM INDUCTION MELT-VACUUM ARC REMELT H-11 STEEL
(HEAT NO. W-24403-1)

LONGITUDINAL TENSILE PROPERTIES
OF VACUUM INDUCTION MELT-VACUUM ARC REMELT
H 11 STEEL HEAT NO. W 24403-1

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
A	14 5	S	231.7	296.3	7.0	18.4	555
A	15 5	S	231.8	295.0	8.5	23.0	555
A	16 5	S	228.7	296.1	9.5	26.5	555
A	18 5	S	233.7	301.0	7.5	17.7	555
A	41 5	M	229.7	298.3	5.5	11.5	555
A	42 5	M	227.0	295.6	7.0	14.9	555
A	43 5	M		302.5	6.0	11.5	555
A	45 5	M	237.5	298.5	6.0	16.1	555
A	46 5	M	231.2	297.1	7.0	14.5	555
A	47 5	M	224.5	297.1	6.0	11.5	555
A	49 5	M	234.5	304.5	6.0	10.5	555
A	50 5	M	229.4	299.3	6.8	19.4	534
A	51 5	M	234.2	297.6	7.0	15.2	555
A	65 5	C	230.1	295.7	5.5	11.9	545
A	67 5	C	222.5	285.4	5.0	11.1	545
B	14 5	S	231.2	308.8	7.5	18.8	555
B	15 5	S	233.3	296.3	7.8	21.3	555
B	16 5	S	229.2	297.6	8.0	19.9	555
B	18 5	S	235.0	299.5	7.5	15.3	555
B	41 5	M	225.2	294.6	5.5	8.9	555
B	42 5	M	229.6	291.8	7.5	21.4	555
B	43 5	M	229.7	290.6	6.5	15.6	555
B	45 5	M	227.5	294.7	4.0	7.7	555
B	46 5	M	227.7	299.6	7.0	17.7	555
B	47 5	M	226.4	298.3	5.0	9.6	555
B	49 5	M	229.5	296.9	6.0	14.2	555
B	50 5	M	232.9	297.8	7.5	19.5	534
B	51 5	M	230.7	291.7	8.0	12.2	555
B	65 5	C	226.4	289.3	5.5	11.9	545
B	67 5	C	224.7	283.8	7.0	14.5	545
C	14 5	S	232.2	299.1	9.5	25.4	555
C	15 5	S	233.0	293.8	8.2	26.1	555
C	16 5	S	239.7	309.6	7.0	15.3	555
C	18 5	S	227.7	294.0	8.5	19.4	555
C	41 5	M	225.2	297.1	6.0	10.4	555
C	42 5	M	230.9	297.8	6.5	15.3	555
C	43 5	M	232.0	293.1	7.5	17.8	555
C	45 5	M	230.0	297.5	4.5	5.8	555
C	46 5	M	233.0	299.0	7.0	15.8	555
C	47 5	M	231.2	297.1	6.5	11.5	555
C	49 5	M	229.0	300.7	5.5	12.0	555
C	50 5	M	236.3	301.3	6.8	18.1	534
C	51 5	M	232.7	296.3	6.5	8.1	555
C	65 5	C	222.8	288.0	5.5	10.7	545
C	67 5	C	222.7	283.3	4.2	6.6	545
D	14 5	S	236.2	296.3	7.0	17.0	534
D	15 5	S	232.8	292.5	8.5	23.7	555
D	16 5	S	238.1	309.4	7.0	18.8	555
D	18 5	S	228.0	292.5	6.5	17.0	555
D	41 5	M	226.4	297.7	4.5	7.2	555
D	42 5	M	234.7	299.2	6.5	16.3	555
D	43 5	M	233.5	294.1	7.0	15.3	555
D	45 5	M	232.7	294.9	7.0	7.8	555
D	46 5	M	230.6	303.2	5.5	10.4	555
D	47 5	M	227.5	294.6	6.0	12.6	555
D	49 5	M	231.8	300.7	5.5	11.6	555
D	50 5	M	231.2	308.3	6.5	13.4	534
D	51 5	M	232.2	294.1	7.0	13.4	555
D	65 5	C	227.8	291.3	5.2	9.2	545
D	67 5	C	224.9	285.3	5.0	10.0	545
E	14 5	S	231.8	304.0	7.5	16.3	534
E	15 5	S	235.5	297.5	7.8	22.0	555
E	16 5	S	233.2	307.5	7.5	20.6	555
E	18 5	S	230.0	297.5	7.0	18.8	555
E	41 5	M	224.7	295.8	5.0	10.7	555
E	42 5	M	233.0	297.5	6.5	15.2	555
E	43 5	M	233.1	293.7	5.0	9.7	555
E	45 5	M	230.0	292.8	4.5	7.3	555
E	46 5	M	232.6	300.2	6.0	13.6	555
E	47 5	M	229.8	300.3	4.0	6.2	555

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
E	49 5	M	227.4	299.6	4.0	6.6	555
E	50 5	M	235.1	307.0	5.5	21.0	534
E	51 5	M	223.9	290.9	5.5	10.1	555
E	65 5	C	223.6	290.3	5.5	9.3	545
E	67 5	C	222.8	285.2	4.5	8.9	545
H	14 5	S	231.2	304.0	8.0	18.8	534
H	15 5	S	232.6	296.1	8.1	23.4	555
H	16 5	S	227.3	299.5	9.0	26.6	555
H	18 5	S	231.0	297.2	7.0	19.5	555
H	41 5	M	222.9	294.6	4.0	8.1	555
H	42 5	M	235.0	306.3	6.5	10.7	555
H	43 5	M	229.7	293.6	4.0	8.5	555
H	45 5	M	227.1	291.8	5.5	10.8	555
H	46 5	M	233.1	304.5	5.5	9.7	555
H	47 5	M	227.2	297.1	4.0	8.5	555
H	49 5	M	226.3	292.0	5.0	10.8	555
H	50 5	M	229.6	308.3	7.0	21.7	534
H	51 5	M	232.2	293.8	5.0	8.1	555
H	65 5	C	224.8	289.4	5.0	9.7	545
H	67 5	C	222.8	284.5	4.5	8.1	545
I	14 5	S	247.1	300.8	7.0	16.3	534
I	15 5	S	234.3	300.0	6.2	13.4	555
I	16 5	S	236.0	299.1	7.5	19.5	555
I	18 5	S	228.5	297.2	6.0	9.6	555
I	41 5	M	227.4	299.6	5.0	8.9	555
I	42 5	M	232.6	296.4	6.0	14.9	555
I	43 5	M	234.5	297.2	4.5	6.3	555
I	45 5	M	231.1	295.0	4.5	9.7	555
I	46 5	M	230.5	307.0	6.5	9.7	555
I	47 5	M	224.7	295.2	5.5	9.8	555
I	49 5	M	227.1	295.7	4.0	7.4	555
I	50 5	M	230.1	303.3	6.0	14.2	534
I	51 5	M	230.2	294.1	6.0	8.9	555
I	65 5	C	228.0	290.5	4.0	7.7	545
I	67 5	C	223.9	288.9	5.0	10.6	545
J	14 5	S	228.1	299.5	8.5	18.5	534
J	15 5	S	232.8	292.5	7.0	18.8	535
J	16 5	S	231.0	294.7	7.0	10.6	555
J	18 5	S	229.0	295.0	7.5	18.4	555
J	41 5	M	229.6	296.4	6.0	14.0	555
J	42 5	M	228.0	293.8	7.0	14.8	555
J	43 5	M	233.1	295.7	6.0	11.9	555
J	45 5	M	226.5	291.3	6.5	14.1	555
J	46 5	M	240.9	307.5	5.0	13.2	555
J	47 5	M	226.3	295.7	6.5	11.6	555
J	49 5	M	227.9	299.6	6.0	10.0	555
J	50 5	M	234.2	308.8	5.5	11.1	555
J	51 5	M	231.7	298.1	6.0	13.7	555
J	65 5	C	227.3	290.8	5.7	12.2	545
J	67 5	C	227.8	291.9	6.0	13.3	545
K	14 5	S	230.4	291.6	9.5	23.0	534
K	15 5	S	230.5	296.3	7.5	19.5	555
K	16 5	S	227.0	293.5	7.0	16.8	555
K	18 5	S	232.0	286.3	7.0	18.8	555
K	41 5	M	225.5	297.1	6.5	10.0	534
K	42 5	M	232.0	297.8	6.0	13.4	555
K	43 5	M	225.2	291.1	5.5	12.2	555
K	45 5	M	237.5	287.3	6.0	15.6	555
K	46 5	M	227.5	293.8	7.0	17.4	534
K	47 5	M	227.7	294.6	6.5	12.2	555
K	49 5	M	232.5	298.2	5.5	13.5	555
K	50 5	M	229.7	298.1	7.0	15.6	555
K	51 5	M	231.2	297.8	4.9	8.5	555
K	65 5	C	230.4	290.9	4.2	8.9	545
K	67 5	C	222.5	281.0	5.0	11.5	545
L	14 5	S	231.5	296.2	8.0	18.2	534
L	15 5	S	228.8	292.5	6.5	17.0	555
L	16 5	S	225.5	291.6	6.5	11.1	555
L	18 5	S	232.0	295.0	8.0	20.2	555
L	41 5	M	222.7	290.3	5.5	9.4	534
L	42 5	M	223.3	292.7	5.0	8.7	545
L	43 5	M	232.0	297.4	5.0	8.5	555
L	45 5	M	225.5	290.0	4.5	10.4	555

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
L	46 5	M	228.3	294.0	5.0	13.4	534
L	47 5	M	229.9	295.8	5.5	10.7	555
L	49 5	M	226.4	290.8	5.5	10.7	555
L	50 5	M	231.2	307.5	5.0	12.2	555
L	51 5	M	230.2	292.8	6.0	11.1	555
L	65 5	C	225.0	291.3	5.0	10.0	545
L	67 5	C	223.7	282.6	6.0	12.6	545
M	14 5	S	228.1	294.2	7.5	14.2	534
M	15 5	S	228.8	287.5	7.0	17.0	555
M	16 5	S	233.1	292.5	8.0	20.3	555
M	18 5	S	227.0	290.0	8.0	19.5	555
M	41 5	M	224.4	293.3	6.0	12.6	534
M	42 5	M	229.3	293.5	7.0	18.9	545
M	43 5	M	232.5	295.7	5.5	13.4	555
M	45 5	M	226.6	292.2	5.5	11.9	555
M	46 5	M	227.5	291.4	5.5	12.7	534
M	47 5	M	226.4	290.8	6.0	11.1	555
M	49 5	M	225.2	292.1	6.0	12.6	555
M	50 5	M	228.1	296.2	3.5	3.2	555
M	51 5	M	231.2	295.6	7.0	10.7	555
M	65 5	C	226.0	290.2	6.5	11.2	545
M	67 5	C	225.2	282.1	6.5	14.1	555
N	14 5	S	224.9	292.3	6.5	14.8	534
N	15 5	S	227.8	285.0	7.0	18.1	555
N	16 5	S	229.5	290.1	7.5	20.0	555
N	18 5	S	229.4	291.8	7.0	17.0	555
N	41 5	M	227.5	299.4	5.0	11.2	534
N	42 5	M	229.0	296.7	7.0	17.3	545
N	43 5	M	231.7	295.3	6.0	11.5	555
N	45 5	M	228.1	290.2	5.5	10.1	555
N	46 5	M	233.1	297.1	5.5	13.8	534
N	47 5	M	221.8	290.9	6.5	12.6	555
N	49 5	M	228.7	298.3	6.0	13.0	555
N	50 5	M	229.2	295.3	5.5	13.4	555
N	51 5	M	230.7	294.6	7.0	12.2	555
N	65 5	C	228.1	289.0	6.2	12.2	545
N	67 5	C	226.9	288.3	5.5	12.2	555
P	14 5	S	230.2	292.6	9.0	20.2	534
P	15 5	S	230.0	288.8	6.5	15.2	555
P	16 5	S	232.2	294.3	7.5	19.5	555
P	18 5	S	231.8	293.8	8.0	20.9	555
P	41 5	M	222.9	295.8	5.0	9.2	534
P	42 5	M	228.0	293.4	6.0	13.0	545
P	43 5	M	226.6	291.7	5.5	10.6	555
P	45 5	M	229.5	294.0	5.0	9.2	555
P	46 5	M	227.5	296.3	8.5	13.0	534
P	47 5	M	222.0	292.2	3.5	7.7	555
P	49 5	M	225.5	295.7	5.0	10.5	555
P	50 5	M	228.2	294.3	6.0	13.4	555
P	51 5	M	228.2	291.8	5.5	11.9	555
P	65 5	C	226.6	289.2	5.0	8.5	545
P	67 5	C	224.8	285.9	6.0	12.7	555
S	14 5	S	227.7	297.9	7.3	13.4	534
S	15 5	S	227.8	293.8	6.5	15.9	555
S	16 5	S	225.6	293.2	6.5	13.4	555
S	18 5	S	226.8	290.0	6.5	14.5	555
S	41 5	M	227.2	299.6	5.5	10.7	534
S	42 5	M	226.3	292.7	4.5	7.0	545
S	43 5	M	222.1	290.5	6.0	12.7	555
S	45 5	M	229.1	295.5	5.5	11.6	555
S	46 5	M	229.5	292.9	5.0	12.0	534
S	47 5	M	222.4	290.8	6.5	14.1	555
S	49 5	M	231.3	293.2	6.5	14.5	555
S	50 5	M	232.2	298.1	7.0	17.7	555
S	51 5	M	234.2	294.6	6.0	12.2	555
S	65 5	C	229.8	291.3	6.0	13.7	545
S	67 5	C	224.7	287.1	6.0	14.1	555
T	14 5	S	224.5	288.7	6.5	10.0	534
T	15 5	S	227.5	287.5	7.5	20.6	555
T	16 5	S	229.2	293.8	7.0	19.5	555
T	18 5	S	224.9	291.0	6.5	15.5	555
T	41 5	M	228.1	293.2	5.5	12.7	535
T	42 5	M	229.5	298.4	4.8	10.0	545

BILLET SECTION	TEST NO	SPECIMEN LOCATION	YLD.STR.KSI .2% OFF	ULT.STR KSI	% ELONG	% R.A.	BHN
T	43 5	M	234.0	294.8	6.0	13.9	555
T	45 5	M	229.1	293.5	5.5	9.3	555
T	46 5	M	222.0	289.8	5.0	9.7	534
T	47 5	M	223.9	289.8	5.0	9.6	555
T	49 5	M	223.4	289.6	5.5	11.1	555
T	50 5	M	226.7	296.3	6.0	13.4	555
T	51 5	M	232.7	289.6	6.0	13.0	555
T	65 5	C	228.3	294.5	5.5	9.6	545
T	67 5	C	226.8	288.4	6.5	13.7	555
V	14 5	S	232.2	296.3	8.5	18.8	534
V	15 5	S	230.0	295.0	8.5	22.0	555
V	16 5	S	229.6	291.7	8.0	22.1	555
V	18 5	S	226.5	289.0	6.5	15.6	555
V	41 5	M	226.2	295.8	6.0	14.1	534
V	42 5	M	226.8	297.0	6.2	16.3	545
V	43 5	M	235.5	292.4	7.0	5.6	555
V	45 5	M	231.3	293.3	4.5	7.4	555
V	46 5	M	231.4	296.5	6.0	17.5	534
V	47 5	M	224.7	290.8	6.0	13.7	555
V	49 5	M	230.2	296.3	6.0	12.2	555
V	50 5	M	229.1	300.2	6.0	13.1	555
V	51 5	M	231.7	295.6	7.0	16.3	555
V	65 5	C	228.3	269.8	5.5	10.0	545
V	67 5	C	228.9	293.3	5.5	10.4	555

SECTION 3

TRANSVERSE NOTCHED TENSILE PROPERTIES OF VACUUM INDUCTION MELT-VACUUM ARC REMELT H-11 STEEL (HEAT NO. W-24403-1)

TRANSVERSE NOTCHED TENSILE PROPERTIES
OF VACUUM INDUCTION MELT-VACUUM ARC REMELT
H-11 STEEL HEAT NO. W-24403-1

BILLET SECTION	TEST NO.	SPECIMEN LOCATION	ULT STR KSI	N/S U.S. RATIO	BHN
A	1 4	S	232.2	0.79	534
A	5 4	S	234.5	0.77	534
A	12 4	S	215.6	0.73	534
A	20 4	M	281.2	0.95	534
A	21 4	M	263.9	0.91	555
A	26 4	M	303.1	1.04	555
A	27 4	M	255.7	0.87	555
A	38 4	M	297.8	0.99	555
A	39 4	M	217.5	0.73	555
A	60 4	C	225.8	0.78	555
A	62 4	C	239.4	0.82	534
B	1 4	S	215.2	0.72	534
B	5 4	S	282.2	0.95	534
B	12 4	S	214.0	0.70	534
B	20 4	M	245.2	0.83	534
B	21 4	M	238.1	0.81	555
B	26 4	M	248.6	0.86	555
B	27 4	M	251.9	0.86	555
B	38 4	M	249.1	0.84	555
B	39 4	M	212.5	0.72	555
B	60 4	C	221.7	0.77	555
B	62 4	C	229.2	0.79	534
C	1 4	S	225.8	0.75	534
C	5 4	S	241.4	0.81	534
C	12 4	S	219.6	0.75	534
C	20 4	M	196.1	0.66	534
C	21 4	M	207.4	0.71	555
C	26 4	M	189.5	0.64	555
C	27 4	M	220.0	0.75	555
C	38 4	M	256.8	0.87	555
C	39 4	M	255.4	0.86	555
C	60 4	C	216.1	0.74	555
C	62 4	C	280.2	0.97	534
D	1 4	S	209.5	0.69	534
D	5 4	S	258.9	0.86	534
D	12 4	S	210.0	0.71	534
D	20 4	M	199.7	0.69	534
D	21 4	M	194.1	0.67	555
D	26 4	M	276.9	0.94	555
D	27 4	M	221.1	0.75	555
D	38 4	M	233.5	0.78	555
D	39 4	M	183.9	0.62	555
D	60 4	C	216.6	0.75	555
D	62 4	C	198.7	0.69	534
E	1 4	S	238.1	0.81	534
E	5 4	S	268.7	0.91	534
E	12 4	S	295.8	1.00	534
E	20 4	M	224.3	0.76	534
E	21 4	M	200.8	0.69	555
E	26 4	M	217.6	0.73	555
E	27 4	M	241.1	0.82	555
E	38 4	M	265.9	0.88	555
E	39 4	M	223.8	0.76	555
E	60 4	C	208.4	0.72	555
E	62 4	C	228.4	0.81	534
H	1 4	S	272.3	0.92	534
H	5 4	S	274.7	0.93	534
H	12 4	S	251.0	0.94	534
H	20 4	M	213.6	0.71	534
H	21 4	M	158.5	0.55	555
H	26 4	M	289.7	0.99	555
H	27 4	M	285.8	0.96	555
H	38 4	M	199.2	0.69	555
H	39 4	M	141.9	0.48	555
H	60 4	C	216.6	0.75	555
H	62 4	C	224.2	0.78	534
I	1 4	S	243.2	0.81	534

BILLET SECTION	TEST NO.	SPECIMEN LOCATION	ULT STR KSI	N/S U.S. RATIO	BHN
I	5 4	S	264.6	0.90	534
I	12 4	S	259.0	0.89	534
I	20 4	M	278.9	0.96	534
I	21 4	M	234.5	0.82	555
I	26 4	M	251.5	0.86	555
I	27 4	M	232.8	0.79	555
I	38 4	M	234.0	0.78	555
I	39 4	M	255.4	0.86	555
I	60 4	C	242.2	0.84	555
I	62 4	C	229.2	0.78	534
J	1 4	S	222.7	0.75	534
J	5 4	S	266.8	0.89	534
J	12 4	S	224.8	0.77	534
J	20 4	M	202.8	0.68	534
J	21 4	M	219.7	0.75	555
J	26 4	M	210.5	0.72	555
J	27 4	M	215.6	0.73	555
J	38 4	M	282.2	0.95	555
J	39 4	M	221.2	0.74	555
J	60 4	C	210.5	0.74	555
J	62 4	C	196.7	0.68	534
K	1 4	S	280.0	0.92	534
K	5 4	S	217.8	0.73	534
K	12 4	S	237.6	0.81	534
K	20 4	M	250.6	0.85	534
K	21 4	M	218.0	0.74	555
K	26 4	M	277.6	0.94	555
K	27 4	M	189.5	0.63	534
K	38 4	M	220.1	0.74	555
K	39 4	M	232.5	0.78	555
K	60 4	C	237.6	0.81	555
K	62 4	C	167.2	0.57	534
L	1 4	S	235.5	0.74	534
L	5 4	S	295.4	1.01	534
L	12 4	S	167.0	0.57	534
L	20 4	M	246.9	0.85	534
L	21 4	M	228.4	0.77	555
L	26 4	M	262.1	0.91	555
L	27 4	M	243.3	0.83	555
L	38 4	M	258.5	0.87	555
L	39 4	M	248.3	0.83	555
L	60 4	C	216.6	0.74	555
L	62 4	C	238.4	0.82	534
M	1 4	S	268.7	0.90	534
M	5 4	S	281.7	0.95	534
M	12 4	S	243.2	0.83	534
M	20 4	M	262.1	0.91	534
M	21 4	M	209.9	0.73	555
M	26 4	M	213.6	0.74	555
M	27 4	M	215.7	0.74	555
M	38 4	M	241.7	0.82	555
M	39 4	M	231.9	0.78	555
M	60 4	C	221.7	0.76	555
M	62 4	C	218.5	0.75	534
N	1 4	S	258.5	0.86	534
N	5 4	S	210.9	0.72	534
N	12 4	S	239.3	0.81	534
N	20 4	M	232.5	0.81	534
N	21 4	M	254.4	0.88	555
N	26 4	M	178.0	0.62	555
N	27 4	M	262.1	0.90	555
N	38 4	M	268.7	0.91	555
N	39 4	M	196.2	0.66	555
N	60 4	C	214.1	0.74	555
N	62 4	C	172.8	0.59	534
P	1 4	S	280.2	0.96	534
P	5 4	S	246.0	0.85	534
P	20 4	M	225.6	0.77	534
P	21 4	M	248.3	0.84	555
P	26 4	M	237.4	0.82	555
P	27 4	M	257.3	0.89	555
P	38 4	M	221.7	0.74	555

BILLET SECTION	TEST NO.	SPECIMEN LOCATION	ULT STR KSI	N/S U.S. RATIO	BHN
P	39 4	M	195.7	0.66	555
P	60 4	C	235.5	0.81	555
P	62 4	C	244.9	0.84	534
S	1 4	S	246.3	0.85	534
S	5 4	S	278.6	0.96	534
S	12 4	S	233.8	0.82	534
S	20 4	M	175.8	0.61	534
S	21 4	M	190.0	0.64	555
S	26 4	M	220.2	0.76	555
S	27 4	M	217.6	0.75	555
S	38 4	M	239.1	0.80	555
S	39 4	M	214.6	0.72	555
S	60 4	C	255.4	0.88	555
S	62 4	C	220.1	0.75	534
T	1 4	S	247.8	0.86	534
T	5 4	S	262.4	0.89	534
T	12 4	S	255.0	0.89	534
T	20 4	M	231.4	0.81	534
T	21 4	M	249.8	0.85	555
T	26 4	M	225.8	0.77	555
T	27 4	M	229.9	0.81	555
T	38 4	M	218.7	0.73	555
T	39 4	M	252.4	0.85	555
T	60 4	C	230.4	0.79	555
T	62 4	C	160.5	0.55	534
V	1 4	S	223.8	0.77	534
V	5 4	S	268.0	0.90	534
V	12 4	S	280.5	0.96	534
V	20 4	M	252.9	0.89	534
V	21 4	M	268.2	0.91	555
V	26 4	M	232.5	0.80	555
V	27 4	M	224.2	0.77	555
V	38 4	M	245.0	0.84	555
V	39 4	M	266.2	0.90	555
V	60 4	C	225.3	0.77	555
V	62 4	C	253.1	0.86	534

SECTION 4

LONGITUDINAL NOTCHED TENSILE PROPERTIES OF
VACUUM INDUCTION MELT-VACUUM ARC REMELT H-11 STEEL
(HEAT NO. W-24403-1)

LONGITUDINAL NOTCHED TENSILE PROPERTIES
OF VACUUM INDUCTION MELT-VACUUM ARC REMELT
H-11 STEEL HEAT NO. W-24403-1

BILLET SECTION	TEST NO.	SPECIMEN LOCATION	ULT STR KSI	N/S U.S. RATIO	BHN
A	13 5	S	316.2	1.07	534
A	17 5	S	303.0	1.01	534
A	40 5	M	303.0	1.02	555
A	44 5	M	312.7	1.05	534
A	48 5	M	300.1	1.00	534
A	64 5	C	221.7	0.75	555
A	66 5	C	297.5	1.04	534
B	13 5	S	304.1	0.99	534
B	17 5	S	265.7	0.89	534
B	40 5	M	295.8	1.01	555
B	44 5	M	280.5	0.94	534
B	48 5	M	273.8	0.92	534
B	64 5	C	246.6	0.85	555
B	66 5	C	214.6	0.76	534
C	13 5	S	307.0	1.03	534
C	17 5	S	280.2	0.95	534
C	40 5	M	276.1	0.93	555
C	44 5	M	306.7	1.03	534
C	48 5	M	303.6	1.01	534
C	64 5	C	255.2	0.89	555
C	66 5	C	257.1	0.91	534
D	13 5	S	284.6	0.96	534
D	17 5	S	283.0	0.97	534
D	40 5	M	253.4	0.85	555
D	44 5	M	211.5	0.70	534
D	48 5	M	315.8	1.02	534
D	64 5	C	266.7	0.92	555
D	66 5	C	279.2	0.98	534
E	13 5	S	257.3	0.85	534
E	17 5	S	311.1	1.05	534
E	40 5	M	280.7	0.94	555
E	44 5	M	204.4	0.68	534
E	48 5	M	257.8	0.84	534
E	64 5	C	232.3	0.80	555
E	66 5	C	235.4	0.83	534
H	13 5	S	319.9	1.05	534
H	17 5	S	243.2	0.82	534
H	40 5	M	298.4	0.97	555
H	44 5	M	256.2	0.84	534
H	48 5	M	257.3	0.83	534
H	64 5	C	226.3	0.78	555
H	66 5	C	248.2	0.87	534
I	13 5	S	271.8	0.90	534
I	17 5	S	264.1	0.89	534
I	40 5	M	285.8	0.96	555
I	44 5	M	284.3	0.93	534
I	48 5	M	236.4	0.78	534
I	64 5	C	212.0	0.73	555
I	66 5	C	222.9	0.77	534
J	13 5	S	305.7	1.02	534
J	17 5	S	234.3	0.79	534
J	40 5	M	267.7	0.91	555
J	44 5	M	255.4	0.83	534
J	48 5	M	264.4	0.86	534
J	64 5	C	214.0	0.74	555
J	66 5	C	231.8	0.79	534
K	13 5	S	310.8	1.07	534
K	17 5	S	274.1	0.96	534
K	40 5	M	281.5	0.95	555
K	44 5	M	267.2	0.91	534
K	48 5	M	284.1	0.95	534
K	64 5	C	266.2	0.91	555
K	66 5	C	233.5	0.83	534
L	13 5	S	268.7	0.91	534
L	17 5	S	258.5	0.88	534

BILLET SECTION	TEST NO.	SPECIMEN LOCATION	ULT STR KSI	N/S U.S. RATIO	BHN
L	40 5	M	290.4	0.99	555
L	44 5	M	232.3	0.79	534
L	48 5	M	245.2	0.80	534
L	64 5	C	225.3	0.77	555
L	66 5	C	245.6	0.87	534
M	13 5	S	286.1	0.97	534
M	17 5	S	268.5	0.93	534
M	40 5	M	287.3	0.92	555
M	44 5	M	231.8	0.80	534
M	48 5	M	206.9	0.70	534
M	64 5	C	256.0	0.88	555
M	66 5	C	204.8	0.73	534
N	13 5	S	316.8	1.08	534
N	17 5	S	243.5	0.83	534
N	40 5	M	217.1	0.73	555
N	44 5	M	247.3	0.83	534
N	48 5	M	252.9	0.86	534
N	64 5	C	246.6	0.85	555
N	66 5	C	251.9	0.87	534
P	13 5	S	275.9	0.94	534
P	17 5	S	293.4	1.00	534
P	40 5	M	225.7	0.77	555
P	44 5	M	267.5	0.90	534
P	48 5	M	246.6	0.84	534
P	64 5	C	262.9	0.91	555
P	66 5	C	255.4	0.89	534
S	13 5	S	276.1	0.93	534
S	17 5	S	255.7	0.88	534
S	40 5	M	270.8	0.93	555
S	44 5	M	186.5	0.64	534
S	48 5	M	271.3	0.91	534
S	64 5	C	236.4	0.81	555
S	66 5	C	215.0	0.75	534
T	13 5	S	313.7	1.09	534
T	17 5	S	219.7	0.75	534
T	40 5	M	292.7	0.98	555
T	44 5	M	257.0	0.89	534
T	48 5	M	217.1	0.73	534
T	64 5	C	263.6	0.90	555
T	66 5	C	226.8	0.79	534
V	13 5	S	253.7	0.86	534
V	17 5	S	259.5	0.90	534
V	40 5	M	215.6	0.73	555
V	44 5	M	229.9	0.78	534
V	48 5	M	259.5	0.86	534
V	64 5	C	238.6	0.82	555
V	66 5	C	228.4	0.78	534

APPENDIX V

HISTOGRAMS FOR ULTIMATE STRENGTH, PER CENT REDUCTION IN AREA, NOTCH ULTIMATE STRENGTH, AND NOTCH/SMOOTH STRENGTH RATIO PLOTTED FOR EACH MELT PROCESS, SPECIMEN DIRECTION, AND CROSS-SECTIONAL LOCATION

SECTION 1

HISTOGRAMS FOR AIR MELT-VACUUM ARC REMELT H-11 STEEL HEAT NO. W-24341-1

Class Mid-Point F_{tu} Ksi	Frequency	
261	1	X
264	1	X
267	1	X
270	1	X
272	3	XXX
275	2	XX
278	8	XXXXXXXX
281	6	XXXXXX
283	27	XXXXXXXXXXXXXXXXXXXXXXXXXXX
286	62	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
289	103	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
292	97	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
294	84	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
297	87	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
300	73	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
302	38	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
305	13	XXXXXXXXXXXXX
308	11	XXXXXXXXXXX
311	8	XXXXXXXX
313	4	XXXX
316	1	X

Number of Tests	631
Arithmetic Mean	293.3
Standard Deviation	7.2
Maximum Value	314.8
Minimum Value	260.0
Standard Deviation of the Mean	.29

Class Mid-Point % R.A.	Frequency	
1.2	15	XXXXXXXXXXXXXXX
2.7	62	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
4.3	107	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
5.8	81	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
7.3	111	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
8.9	72	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
10.4	57	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
11.9	38	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
13.5	20	XXXXXXXXXXXXXXXXXXXX
15.0	18	XXXXXXXXXXXXXXXXXX
16.6	17	XXXXXXXXXXXXXXXXX
18.1	12	XXXXXXXXXXXX
19.6	7	XXXXXXX
21.2	6	XXXXXX
22.7	3	XXX
24.3	1	X
25.8	0	
27.3	1	X
28.9	2	XX
30.4	1	X
32.0	1	X

Number of Tests	632
Arithmetic Mean	8.1
Standard Deviation	4.8
Maximum Value	31.2
Minimum Value	0.4
Standard Deviation of the Mean	0.19

FIGURE 5-1

HISTOGRAMS FOR SMOOTH SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
262	1	X
265	1	X
268	1	X
271	2	XX
275	3	XXX
278	7	XXXXXXX
281	10	XXXXXXXXXX
284	39	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
287	59	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
291	78	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
294	73	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
297	52	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
300	41	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
304	15	XXXXXXXXXXXXXXX
307	4	XXXX
310	4	XXXX
313	3	XXX
316	1	X

Number of Tests	394
Arithmetic Mean	292.2
Standard Deviation	7.2
Maximum Value	314.8
Minimum Value	260.0
Standard Deviation of the Mean	.36

Class Mid-Point % R.A.	Frequency	
0.9	7	XXXXXXX
2.0	26	XXXXXXXXXXXXXXXXXXXXXXXXXX
3.0	51	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
4.0	48	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
5.1	57	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
6.1	43	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
7.2	35	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
8.2	24	XXXXXXXXXXXXXXXXXXXXXXXX
9.3	30	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
10.3	22	XXXXXXXXXXXXXXXXXXXXXX
11.3	15	XXXXXXXXXXXXXXX
12.4	8	XXXXXXXX
13.4	12	XXXXXXXXXXXX
14.5	9	XXXXXXXXX
15.5	5	XXXXX
16.5	1	X
17.6	0	
18.6	1	X

Number of Tests	394
Arithmetic Mean	6.6
Standard Deviation	3.5
Maximum Value	18.1
Minimum Value	0.4
Standard Deviation of the Mean	0.17

FIGURE 5-2

HISTOGRAMS FOR SMOOTH TRANSVERSE SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
262	1	X
266	1	X
270	0	
273	0	
277	3	XXX
281	1	X
285	7	XXXXXXX
289	39	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
293	48	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
296	25	XXXXXXXXXXXXXXXXXXXXXXXXX
300	17	XXXXXXXXXXXXXXXXX
304	1	X
308	0	
312	0	
316	1	X

Number of Tests	144
Arithmetic Mean	292.2
Standard Deviation	6.2
Maximum Value	313.8
Minimum Value	260.0
Standard Deviation of the Mean	0.51

Class Mid-Point % R.A.	Frequency	
1.0	1	X
2.3	6	XXXXXX
3.6	11	XXXXXXXXXXX
4.8	7	XXXXXXX
6.1	19	XXXXXXXXXXXXXXXXXXX
7.4	13	XXXXXXXXXXXXX
8.6	18	XXXXXXXXXXXXXXXXXX
9.9	22	XXXXXXXXXXXXXXXXXXXXXX
11.1	13	XXXXXXXXXXXXX
12.4	7	XXXXXXX
13.7	15	XXXXXXXXXXXXXXX
14.9	6	XXXXXX
16.2	4	XXXX
17.5	1	X
18.7	1	X

Number of Tests	144
Arithmetic Mean	9.0
Standard Deviation	3.7
Maximum Value	18.1
Minimum Value	0.4
Standard Deviation of the Mean	0.31

FIGURE 5-3

HISTOGRAMS FOR SMOOTH TRANSVERSE SURFACE SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
266	1	X
269	1	X
272	2	XX
275	0	
278	2	XX
281	3	XXX
284	15	XXXXXXXXXXXXXXX
287	29	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
290	36	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
293	35	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
296	35	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
299	27	XXXXXXXXXXXXXXXXXXXXXXXXXXX
302	20	XXXXXXXXXXXXXXXXXXXX
305	4	XXXX
307	3	XXX
310	4	XXXX
313	2	XX
316	1	X

Number of Tests	220
Arithmetic Mean	293.2
Standard Deviation	7.4
Maximum Value	314.8
Minimum Value	264.8
Standard Deviation of the Mean	0.50

Class Mid-Point % R.A.	Frequency	
1.2	5	XXXXX
1.9	4	XXXX
2.7	28	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
3.4	29	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
4.1	23	XXXXXXXXXXXXXXXXXXXXXXX
4.9	39	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
5.6	17	XXXXXXXXXXXXXXXXX
6.4	26	XXXXXXXXXXXXXXXXXXXXXXXXXX
7.1	11	XXXXXXXXXXX
7.8	14	XXXXXXXXXXXXXX
8.6	4	XXXX
9.3	3	XXX
10.1	8	XXXXXXXX
10.8	3	XXX
11.5	4	XXXX
12.3	0	
13.0	1	X
13.8	1	X

Number of Tests	220
Arithmetic Mean	5.3
Standard Deviation	2.4
Maximum Value	13.4
Minimum Value	0.8
Standard Deviation of the Mean	0.16

FIGURE 5-4

HISTOGRAMS FOR SMOOTH TRANSVERSE MID-RADIUS SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
275	2	XX
278	2	XX
281	4	XXXX
284	8	XXXXXXXX
286	12	XXXXXXXXXXXX
289	0	
292	1	X
295	0	
298	1	X

Number of Tests	30
Arithmetic Mean	283.7
Standard Deviation	4.4
Maximum Value	296.5
Minimum Value	273.4
Standard Deviation of the Mean	0.79

Class Mid-Point % R.A.	Frequency	
1.5	2	XX
2.2	3	XXX
3.0	5	XXXXX
3.7	10	XXXXXXXXXX
4.5	3	XXX
5.2	1	X
6.0	2	XX
6.7	3	XXX
7.5	1	X

Number of Tests	30
Arithmetic Mean	4.0
Standard Deviation	1.6
Maximum Value	7.1
Minimum Value	1.1
Standard Deviation of the Mean	0.30

FIGURE 5-5

HISTOGRAMS FOR SMOOTH TRANSVERSE CENTER SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
276	1	X
278	1	X
280	0	
282	0	
285	10	XXXXXXXXXX
287	20	XXXXXXXXXXXXXXXXXXXX
289	31	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
291	25	XXXXXXXXXXXXXXXXXXXXXXXXX
293	22	XXXXXXXXXXXXXXXXXXXXXX
296	27	XXXXXXXXXXXXXXXXXXXXXXXXXXX
298	34	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
300	26	XXXXXXXXXXXXXXXXXXXXXXXXXX
302	12	XXXXXXXXXXXX
305	12	XXXXXXXXXXXX
307	8	XXXXXXXX
309	5	XXXXX
311	2	XX
314	1	X

Number of Tests	237
Arithmetic Mean	295.3
Standard Deviation	6.6
Maximum Value	312.5
Minimum Value	274.5
Standard Deviation of the Mean	0.43

Class Mid-Point % R.A.	Frequency	
3.5	11	XXXXXXXXXXX
5.2	30	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
6.9	50	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
8.6	33	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
10.2	30	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
11.9	23	XXXXXXXXXXXXXXXXXXXXXXX
13.6	4	XXXX
15.3	12	XXXXXXXXXXXX
16.9	15	XXXXXXXXXXXXXXX
18.6	10	XXXXXXXXXX
20.3	7	XXXXXXX
22.0	4	XXXX
23.7	3	XXX
25.3	1	X
27.0	0	
28.7	3	XXX
30.4	1	X
32.0	1	X

Number of Tests	238
Arithmetic Mean	10.7
Standard Deviation	5.5
Maximum Value	31.2
Minimum Value	2.7
Standard Deviation of the Mean	0.36

FIGURE 5-6

HISTOGRAMS FOR SMOOTH LONGITUDINAL SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
292	3	XXX
294	4	XXXX
296	11	XXXXXXXXXXX
298	14	XXXXXXXXXXXXXX
300	12	XXXXXXXXXXXX
302	5	XXXXX
304	3	XXX
306	2	XX
308	6	XXXXXX
310	1	X
312	1	X
313	1	X

Number of Tests	63
Arithmetic Mean	299.7
Standard Deviation	4.8
Maximum Value	312.5
Minimum Value	291.0
Standard Deviation of the Mean	0.61

Class Mid-Point % R.A.	Frequency	
8.1	4	XXXX
10.3	4	XXXX
12.5	5	XXXXX
14.7	9	XXXXXXXXX
16.9	16	XXXXXXXXXXXXXXXX
19.1	10	XXXXXXXXXX
21.3	7	XXXXXXX
23.5	4	XXXX
25.7	0	
27.9	2	XX
30.1	2	XX
32.3	1	X

Number of Tests	64
Arithmetic Mean	17.5
Standard Deviation	5.3
Maximum Value	31.2
Minimum Value	7.0
Standard Deviation of the Mean	0.66

FIGURE 5-7

HISTOGRAMS FOR SMOOTH LONGITUDINAL SURFACE SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
276	2	XX
278	0	
281	0	
284	4	XXXX
286	18	XXXXXXXXXXXXXXXXXX
289	37	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
291	20	XXXXXXXXXXXXXXXXXXXX
294	9	XXXXXXXXX
297	14	XXXXXXXXXXXXXX
299	14	XXXXXXXXXXXXXX
302	12	XXXXXXXXXXXX
304	7	XXXXXXX
307	3	XXX
310	1	X
312	1	X

Number of Tests	142
Arithmetic Mean	293.2
Standard Deviation	6.6
Maximum Value	310.8
Minimum Value	274.5
Standard Dev'ation of the Mean	0.56

Class Mid-Point % R.A.	Frequency	
3.3	4	XXXX
4.4	10	XXXXXXXXXX
5.5	16	XXXXXXXXXXXXXXXX
6.7	23	XXXXXXXXXXXXXXXXXXXXXXX
7.8	29	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
8.9	14	XXXXXXXXXXXXXX
10.0	17	XXXXXXXXXXXXXXXXX
11.2	13	XXXXXXXXXXXXX
12.3	7	XXXXXXX
13.4	1	X
14.5	2	XX
15.7	2	XX
16.8	1	X
17.9	2	XX
19.1	1	X

Number of Tests	142
Arithmetic Mean	8.3
Standard Deviation	3.0
Maximum Value	18.5
Minimum Value	2.7
Standard Deviation of the Mean	0.25

FIGURE 5-8

HISTOGRAMS FOR SMOOTH LONGITUDINAL MID-RADIUS SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
291	9	XXXXXXXXX
294	8	XXXXXXXX
296	5	XXXXX
299	1	X
301	4	XXXX
304	2	XX
306	1	X
309	1	X
311	1	X

Number of Tests	32
Arithmetic Mean	295.9
Standard Deviation	5.3
Maximum Value	310.0
Minimum Value	290.0
Standard Deviation of the Mean	0.94

Class Mid-Point % R.A.	Frequency	
4.5	2	XX
5.6	9	XXXXXXXXX
6.7	1	X
7.8	6	XXXXXX
8.9	6	XXXXXX
10.0	1	X
11.0	4	XXXX
12.1	2	XX
13.2	1	X

Number of Tests	32
Arithmetic Mean	7.9
Standard Deviation	2.4
Maximum Value	12.7
Minimum Value	3.9
Standard Deviation of the Mean	0.43

FIGURE 5-9

HISTOGRAMS FOR SMOOTH LONGITUDINAL CENTER SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
119	2	XX
130	2	XX
141	6	XXXXXX
152	10	XXXXXXXXXX
163	9	XXXXXXXXX
174	19	XXXXXXXXXXXXXXXXXXX
185	18	XXXXXXXXXXXXXXXXXX
196	23	XXXXXXXXXXXXXXXXXXXXXXX
207	23	XXXXXXXXXXXXXXXXXXXXXXX
218	23	XXXXXXXXXXXXXXXXXXXXXXX
229	32	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
240	34	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
251	22	XXXXXXXXXXXXXXXXXXXXXX
262	25	XXXXXXXXXXXXXXXXXXXXXXXXX
273	21	XXXXXXXXXXXXXXXXXXXXX
284	16	XXXXXXXXXXXXXXXX
295	0	
306	1	X

Number of Tests	286
Arithmetic Mean	221.7
Standard Deviation	39.3
Maximum Value	300.5
Minimum Value	113.2
Standard Deviation of the Mean	0.23

Class Mid-Point N/S Ratio	Frequency	
.371	1	X
.414	1	X
.456	1	X
.498	7	XXXXXXX
.541	16	XXXXXXXXXXXXXXXX
.583	13	XXXXXXXXXXXXX
.625	20	XXXXXXXXXXXXXXXXXXXX
.668	19	XXXXXXXXXXXXXXXXXXX
.710	34	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.752	30	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.795	28	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
.837	42	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.879	36	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.922	18	XXXXXXXXXXXXXXXXXX
.964	11	XXXXXXXXXXX
1.01	4	XXXX
1.05	1	X
1.09	1	X

Number of Tests	283
Arithmetic Mean	0.76
Standard Deviation	0.131
Maximum Value	1.07
Minimum Value	0.35
Standard Deviation of the Mean	0.0078

FIGURE 5-10

HISTOGRAMS FOR NOTCHED SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
119	2	XX
132	2	XX
144	10	XXXXXXXXXX
157	8	XXXXXXXX
169	17	XXXXXXXXXXXXXXXXX
181	18	XXXXXXXXXXXXXXXXXX
194	19	XXXXXXXXXXXXXXXXXXX
206	17	XXXXXXXXXXXXXXXXX
219	14	XXXXXXXXXXXXXX
231	23	XXXXXXXXXXXXXXXXXXXXXXX
244	18	XXXXXXXXXXXXXXXXXX
256	13	XXXXXXXXXXXXX
268	7	XXXXXXX
281	7	XXXXXXX
293	1	X

Number of Tests	176
Arithmetic Mean	208.6
Standard Deviation	38.8
Maximum Value	287.0
Minimum Value	113.2
Standard Deviation of the Mean	2.92

Class Mid-Point N/S Ratio	Frequency	
.374	1	X
.422	1	X
.470	3	XXX
.517	13	XXXXXXXXXXXXX
.565	10	XXXXXXXXXX
.613	19	XXXXXXXXXXXXXXXXXXX
.661	18	XXXXXXXXXXXXXXXXXX
.709	27	XXXXXXXXXXXXXXXXXXXXXXXXXXX
.757	21	XXXXXXXXXXXXXXXXXXXXX
.805	18	XXXXXXXXXXXXXXXXXX
.852	18	XXXXXXXXXXXXXXXXXX
.900	17	XXXXXXXXXXXXXXXXX
.948	4	XXXX
.996	1	X
1.04	1	X

Number of Tests	172
Arithmetic Mean	0.72
Standard Deviation	0.129
Maximum Value	1.02
Minimum Value	0.35
Standard Deviation of the Mean	0.0098

FIGURE 5-11

HISTOGRAMS FOR NOTCHED TRANSVERSE SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
155	2	XX
172	2	XX
189	4	XXXX
206	0	
223	7	XXXXXXX
240	15	XXXXXXXXXXXXXXX
257	13	XXXXXXXXXXXXX
274	4	XXXX
291	1	X

Number of Tests	48
Arithmetic Mean	236.1
Standard Deviation	31.5
Maximum Value	282.3
Minimum Value	146.0
Standard Deviation of the Mean	4.55

Class Mid-Point N/S Ratio	Frequency	
.514	2	XX
.581	1	X
.649	0	
.716	3	XXX
.784	11	XXXXXXXXXXX
.851	20	XXXXXXXXXXXXXXXXXXXX
.919	8	XXXXXXXX
.986	2	XX
1.05	1	X

Number of Tests	48
Arithmetic Mean	0.83
Standard Deviation	0.101
Maximum Value	1.02
Minimum Value	0.48
Standard Deviation of the Mean	0.0146

FIGURE 5-12

HISTOGRAMS FOR NOTCHED TRANSVERSE SURFACE SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
121	2	XX
137	4	XXXX
153	9	XXXXXXXXX
168	11	XXXXXXXXXXX
184	10	XXXXXXXXXX
200	15	XXXXXXXXXXXXXXX
216	16	XXXXXXXXXXXXXXXX
232	13	XXXXXXXXXXXXX
247	6	XXXXXX
263	6	XXXXXX
279	3	XXX
295	1	X

Number of Tests	96
Arithmetic Mean	202.8
Standard Deviation	38.8
Maximum Value	287.0
Minimum Value	113.2
Standard Deviation of the Mean	3.96

Class Mid-Point N/S Ratio	Frequency	
.377	1	X
.430	0	
.484	3	XXX
.538	11	XXXXXXXXXXX
.591	9	XXXXXXXXX
.645	18	XXXXXXXXXXXXXXXXXX
.699	16	XXXXXXXXXXXXXXXX
.752	13	XXXXXXXXXXXXX
.806	11	XXXXXXXXXXX
.860	6	XXXXXX
.913	5	XXXXX
.967	1	X

Number of Tests	94
Arithmetic Mean	0.69
Standard Deviation	0.116
Maximum Value	0.94
Minimum Value	0.35
Standard Deviation of the Mean	0.0120

FIGURE 5-13

HISTOGRAMS FOR NOTCHED TRANSVERSE MID-RADIUS SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
147	4	XXXX
159	0	
171	7	XXXXXXX
183	7	XXXXXXX
195	7	XXXXXXX
206	4	XXXX
218	1	X
230	0	
242	2	XX

Number of Tests	32
Arithmetic Mean	185.0
Standard Deviation	23.3
Maximum Value	236.0
Minimum Value	141.3
Standard Deviation of the Mean	4.1

Class Mid-Point N/S Ratio	Frequency	
.432	1	X
.477	1	X
.522	4	XXXX
.567	2	XX
.612	6	XXXXXX
.657	5	XXXXX
.702	6	XXXXXX
.747	4	XXXX
.792	1	X

Number of Tests	30
Arithmetic Mean	0.63
Standard Deviation	0.092
Maximum Value	0.77
Minimum Value	0.41
Standard Deviation of the Mean	0.0168

FIGURE 5-14

HISTOGRAMS FOR NOTCHED TRANSVERSE CENTER SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
182	5	XXXXX
190	7	XXXXXXX
199	3	XXX
208	4	XXXX
217	8	XXXXXXXX
226	8	XXXXXXXX
234	12	XXXXXXXXXXXX
243	10	XXXXXXXXXX
252	11	XXXXXXXXXXX
261	9	XXXXXXXXX
270	17	XXXXXXXXXXXXXXXXX
278	11	XXXXXXXXXXX
287	4	XXXX
296	0	
305	1	X

Number of Tests	110
Arithmetic Mean	242.3
Standard Deviation	30.0
Maximum Value	300.5
Minimum Value	177.2
Standard Deviation of the Mean	2.86

Class Mid-Point N/S Ratio	Frequency	
.511	2	XX
.552	0	
.594	2	XX
.635	7	XXXXXXX
.676	3	XXX
.718	6	XXXXXX
.759	13	XXXXXXXXXXXXX
.801	21	XXXXXXXXXXXXXXXXXXXXX
.842	16	XXXXXXXXXXXXXXXX
.884	17	XXXXXXXXXXXXXXXXX
.925	10	XXXXXXXXXX
.966	10	XXXXXXXXXX
1.01	2	XX
1.05	1	X
1.09	1	X

Number of Tests	111
Arithmetic Mean	0.82
Standard Deviation	0.108
Maximum Value	1.07
Minimum Value	0.49
Standard Deviation of the Mean	0.0103

FIGURE 5-15

HISTOGRAMS FOR NOTCHED LONGITUDINAL SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
212	1	X
224	1	X
235	1	X
247	8	XXXXXXXX
259	5	XXXXX
271	8	XXXXXXXX
283	7	XXXXXXX
295	0	
306	1	X

Number of Tests	32
Arithmetic Mean	261.6
Standard Deviation	19.6
Maximum Value	300.5
Minimum Value	205.8
Standard Deviation of the Mean	3.46

Class Mid-Point N/S Ratio	Frequency	
.657	1	X
.712	1	X
.767	5	XXXXX
.822	9	XXXXXXXXX
.877	7	XXXXXXX
.932	4	XXXX
.987	4	XXXX
1.04	0	
1.10	1	X

Number of Tests	32
Arithmetic Mean	0.86
Standard Deviation	0.088
Maximum Value	1.07
Minimum Value	0.63
Standard Deviation of the Mean	0.0156

FIGURE 5-16

HISTOGRAMS FOR NOTCHED LONGITUDINAL SURFACE SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
191	4	XXXX
204	1	X
216	2	XX
228	5	XXXXX
241	6	XXXXXX
253	8	XXXXXXXX
265	10	XXXXXXXXXX
278	10	XXXXXXXXXX
290	1	X

Number of Tests	47
Arithmetic Mean	249.1
Standard Deviation	26.5
Maximum Value	284.0
Minimum Value	185.1
Standard Deviation of the Mean	3.86

Class Mid-Point N/S Ratio	Frequency	
.646	2	XX
.697	3	XXX
.748	3	XXX
.799	8	XXXXXXXX
.851	8	XXXXXXXX
.902	13	XXXXXXXXXXXXX
.953	7	XXXXXXX
1.00	2	XX
1.06	1	X

Number of Tests	47
Arithmetic Mean	0.85
Standard Deviation	0.092
Maximum Value	1.03
Minimum Value	0.62
Standard Deviation of the Mean	0.0134

FIGURE 5-17

HISTOGRAMS FOR NOTCHED LONGITUDINAL MID-RADIUS SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
183	4	XXXX
195	5	XXXXX
206	4	XXXX
218	9	XXXXXXXXX
230	6	XXXXXX
242	2	XX
253	0	
265	0	
277	1	X

Number of Tests	31
Arithmetic Mean	213.0
Standard Deviation	21.2
Maximum Value	270.8
Minimum Value	177.2
Standard Deviation of the Mean	3.80

Class Mid-Point N/S Ratio	Frequency	
.521	2	XX
.582	2	XX
.643	5	XXXXX
.704	4	XXXX
.766	10	XXXXXXXXXX
.827	7	XXXXXXX
.888	0	
.949	1	X
1.01	1	X

Number of Tests	32
Arithmetic Mean	0.74
Standard Deviation	0.107
Maximum Value	0.98
Minimum Value	0.49
Standard Deviation of the Mean	0.0188

FIGURE 5-18

HISTOGRAMS FOR NOTCHED LONGITUDINAL CENTER SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-VAR BILLET

SECTION 2

HISTOGRAMS FOR AIR MELT-DEGAS-VACUUM ARC REMELT H-11 STEEL HEAT NO. W-24342-V1

Class Mid-Point F_{tu} Ksi	Frequency	
206	1	X
212	0	
217	0	
223	0	
228	0	
234	0	
240	0	
245	0	
251	0	
256	1	X
262	2	XX
267	0	
273	1	X
278	7	XXXXXXX
284	48	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
289	111	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
295	175	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
300	161	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
306	120	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
312	9	XXXXXXXXX
317	1	X

Number of Tests	637
Arithmetic Mean	296.4
Standard Deviation	8.3
Maximum Value	314.3
Minimum Value	203.5
Standard Deviation of the Mean	0.33

Class Mid-Point % R.A.	Frequency	
0.6	5	XXXXX
1.8	19	XXXXXXXXXXXXXXXXXXX
3.0	55	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
4.2	96	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
5.3	107	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
6.5	86	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
7.7	56	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
8.9	48	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
10.1	42	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
11.3	32	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
12.4	32	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
13.6	14	XXXXXXXXXXXXXX
14.8	11	XXXXXXXXXXX
16.0	10	XXXXXXXXXX
17.2	6	XXXXXX
18.4	3	XXX
19.6	3	XXX
20.7	5	XXXXX
21.9	3	XXX
23.1	3	XXX
24.3	1	X

Number of Tests	637
Arithmetic Mean	7.5
Standard Deviation	4.1
Maximum Value	23.7
Minimum Value	0
Standard Deviation of the Mean	0.16

FIGURE 5-19

HISTOGRAMS FOR SMOOTH SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-DEGAS-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
207	1	X
213	0	
220	0	
226	0	
232	0	
239	0	
245	0	
252	0	
258	1	X
264	2	XX
271	0	
277	4	XXXX
284	43	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
290	118	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
296	139	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
303	68	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
309	22	XXXXXXXXXXXXXXXXXXXXXX
316	1	X

Number of Tests	399
Arithmetic Mean	294.3
Standard Deviation	8.5
Maximum Value	312.5
Minimum Value	203.5
Standard Deviation of the Mean	0.43

Class Mid-Point % R.A.	Frequency	
1.3	7	XXXXXXX
2.4	30	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3.5	58	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
4.5	70	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
5.6	44	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
6.6	50	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
7.7	36	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
8.7	26	XXXXXXXXXXXXXXXXXXXXXXXXXX
9.8	22	XXXXXXXXXXXXXXXXXXXXXX
10.9	19	XXXXXXXXXXXXXXXXXXX
11.9	13	XXXXXXXXXXXXX
13.0	11	XXXXXXXXXXX
14.0	2	XX
15.1	6	XXXXXX
16.2	3	XXX
17.2	0	
18.3	0	
19.3	1	X

Number of Tests	398
Arithmetic Mean	6.5
Standard Deviation	3.24
Maximum Value	18.8
Minimum Value	0.8
Standard Deviation of the Mean	0.16

FIGURE 5-20

HISTOGRAMS FOR SMOOTH TRANSVERSE SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-DEGAS-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
259	1	X
262	1	X
266	0	
269	0	
273	0	
276	2	XX
279	0	
283	16	XXXXXXXXXXXXXXXX
286	31	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
290	28	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
293	26	XXXXXXXXXXXXXXXXXXXXXXXXXX
296	24	XXXXXXXXXXXXXXXXXXXXXXXX
300	12	XXXXXXXXXXXX
303	1	X
307	2	XX

Number of Tests	144
Arithmetic Mean	290.4
Standard Deviation	6.6
Maximum Value	305.0
Minimum Value	257.2
Standard Deviation of the Mean	0.55

Class Mid-Point % R.A.	Frequency	
1.7	3	XXX
3.0	7	XXXXXXX
4.3	12	XXXXXXXXXXXX
5.5	21	XXXXXXXXXXXXXXXXXXXXX
6.8	26	XXXXXXXXXXXXXXXXXXXXXXXXXX
8.1	17	XXXXXXXXXXXXXXXXX
9.3	15	XXXXXXXXXXXXXXX
10.6	19	XXXXXXXXXXXXXXXXXXX
11.8	10	XXXXXXXXXX
13.1	7	XXXXXXX
14.4	2	XX
15.6	3	XXX
16.9	1	X
18.2	0	
19.4	1	X

Number of Tests	144
Arithmetic Mean	8.1
Standard Deviation	3.3
Maximum Value	18.8
Minimum Value	1.1
Standard Deviation of the Mean	0.28

FIGURE 5-21

HISTOGRAMS FOR SMOOTH TRANSVERSE SURFACE SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA - AIR MELT-DEGAS-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
207	1	X
213	0	
220	0	
226	0	
232	0	
239	0	
245	0	
252	0	
258	0	
264	0	
271	0	
277	2	XX
284	6	XXXXXX
290	51	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
296	81	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
303	59	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
309	22	XXXXXXXXXXXXXXXXXXXXXX
316	1	X

Number of Tests	223
Arithmetic Mean	297.0
Standard Deviation	8.9
Maximum Value	312.5
Minimum Value	203.5
Standard Deviation of the Mean	0.60

Class Mid-Point % R.A.	Frequency	
1.6	9	XXXXXXXXX
2.5	17	XXXXXXXXXXXXXXXXX
3.4	30	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
4.3	42	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
5.2	26	XXXXXXXXXXXXXXXXXXXXXXXXXX
6.1	22	XXXXXXXXXXXXXXXXXXXXXX
7.0	24	XXXXXXXXXXXXXXXXXXXXXXXX
7.9	14	XXXXXXXXXXXXXX
8.9	13	XXXXXXXXXXXXX
9.8	7	XXXXXXX
10.7	6	XXXXXX
11.6	2	XX
12.5	4	XXXX
13.4	3	XXX
14.3	0	
15.2	2	XX
16.1	0	
17.1	1	X

Number of Tests	222
Arithmetic Mean	5.8
Standard Deviation	2.8
Maximum Value	16.6
Minimum Value	1.1
Standard Deviation of the Mean	0.19

FIGURE 5-22

HISTOGRAMS FOR SMOOTH TRANSVERSE MID-RADIUS SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-DEGAS-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
267	1	X
272	0	
277	0	
282	1	X
287	3	XXX
292	15	XXXXXXXXXXXXXXX
297	11	XXXXXXXXXXX
302	0	
308	1	X

Number of Tests	32
Arithmetic Mean	292.6
Standard Deviation	6.6
Maximum Value	305.0
Minimum Value	264.2
Standard Deviation of the Mean	1.17

Class Mid-Point % R.A.	Frequency	
1.7	6	XXXXXX
3.4	10	XXXXXXXXXX
5.1	12	XXXXXXXXXXXX
6.9	3	XXX
8.6	0	
10.4	0	
12.1	0	
13.8	0	
15.6	1	X

Number of Tests	32
Arithmetic Mean	4.3
Standard Deviation	2.4
Maximum Value	14.7
Minimum Value	0.8
Standard Deviation of the Mean	0.42

FIGURE 5-23

HISTOGRAMS FOR SMOOTH TRANSVERSE CENTER SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-DEGAS-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
279	3	XXX
281	3	XXX
283	2	XX
286	5	XXXXX
288	7	XXXXXXX
290	4	XXXX
292	6	XXXXXX
294	16	XXXXXXXXXXXXXXXX
296	17	XXXXXXXXXXXXXXXXX
298	21	XXXXXXXXXXXXXXXXXXXXX
300	42	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
303	39	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
305	38	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
307	22	XXXXXXXXXXXXXXXXXXXXXX
309	10	XXXXXXXXXX
311	2	XX
313	0	
315	1	X

Number of Tests	238
Arithmetic Mean	299.8
Standard Deviation	6.5
Maximum Value	314.3
Minimum Value	278.1
Standard Deviation of the Mean	0.42

Class Mid-Point % R.A.	Frequency	
0.7	1	X
2.1	3	XXX
3.5	6	XXXXXX
4.9	47	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
6.3	42	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
7.7	30	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
9.1	24	XXXXXXXXXXXXXXXXXXXXXXXX
10.5	21	XXXXXXXXXXXXXXXXXXXXX
11.8	16	XXXXXXXXXXXXXXXX
13.2	12	XXXXXXXXXXXX
14.6	9	XXXXXXXXX
16.0	11	XXXXXXXXXXX
17.4	2	XX
18.8	1	X
20.2	5	XXXXX
21.6	5	XXXXX
23.0	3	XXX
24.4	1	X

Number of Tests	239
Arithmetic Mean	9.2
Standard Deviation	4.8
Maximum Value	23.7
Minimum Value	0
Standard Deviation of the Mean	0.31

FIGURE 5-24

HISTOGRAMS FOR SMOOTH LONGITUDINAL SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-DEGAS-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
280	3	XXX
282	5	XXXXX
285	4	XXXX
288	9	XXXXXXXXX
291	6	XXXXXX
293	10	XXXXXXXXXX
296	8	XXXXXXXX
299	5	XXXXX
302	2	XX
305	6	XXXXXX
307	4	XXXX
310	2	XX

Number of Tests	64
Arithmetic Mean	293.7
Standard Deviation	8.1
Maximum Value	308.8
Minimum Value	278.1
Standard Deviation of the Mean	1.02

Class Mid-Point % R.A.	Frequency	
5.2	2	XX
7.0	2	XX
8.7	3	XXX
10.5	15	XXXXXXXXXXXXXXX
12.2	10	XXXXXXXXXX
14.0	7	XXXXXXX
15.8	11	XXXXXXXXXXX
17.5	2	XX
19.3	3	XXX
21.1	3	XXX
22.8	5	XXXXX
24.6	1	X

Number of Tests	64
Arithmetic Mean	14.0
Standard Deviation	4.7
Maximum Value	23.7
Minimum Value	4.3
Standard Deviation of the Mean	0.58

FIGURE 5-25

HISTOGRAMS FOR SMOOTH LONGITUDINAL SURFACE SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-DEGAS-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
291	1	X
293	2	XX
294	3	XXX
296	3	XXX
298	8	XXXXXXXX
300	19	XXXXXXXXXXXXXXXXXXX
301	24	XXXXXXXXXXXXXXXXXXXXXXXX
303	42	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
305	13	XXXXXXXXXXXXX
306	16	XXXXXXXXXXXXXXXX
308	8	XXXXXXXX
310	3	XXX
312	1	X
313	0	
315	1	X

Number of Tests	144
Arithmetic Mean	302.6
Standard Deviation	3.7
Maximum Value	314.3
Minimum Value	290.0
Standard Deviation of the Mean	0.31

Class Mid-Point % R.A.	Frequency	
3.0	4	XXXX
4.5	34	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
5.9	39	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
7.4	24	XXXXXXXXXXXXXXXXXXXXXXXX
8.9	15	XXXXXXXXXXXXXXX
10.3	5	XXXXX
11.8	10	XXXXXXXXXX
13.2	5	XXXXX
14.7	2	XX
16.1	3	XXX
17.6	0	
19.1	0	
20.5	1	X
22.0	1	X
23.4	1	X

Number of Tests	144
Arithmetic Mean	7.6
Standard Deviation	3.6
Maximum Value	22.7
Minimum Value	2.3
Standard Deviation of the Mean	0.30

FIGURE 5-26

HISTOGRAMS FOR SMOOTH LONGITUDINAL MID-RADIUS SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-DEGAS-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
295	5	XXXXX
297	5	XXXXX
299	11	XXXXXXXXXXX
301	3	XXX
304	2	XX
306	3	XXX
308	0	
310	0	
312	1	X

Number of Tests	30
Arithmetic Mean	299.7
Standard Deviation	3.7
Maximum Value	311.2
Minimum Value	293.9
Standard Deviation of the Mean	0.68

Class Mid-Point % R.A.	Frequency	
0.7	1	X
2.0	0	
3.3	1	X
4.7	6	XXXXXX
6.0	10	XXXXXXXXXX
7.4	5	XXXXX
8.7	3	XXX
10.0	4	XXXX
11.4	1	X

Number of Tests	31
Arithmetic Mean	6.7
Standard Deviation	2.3
Maximum Value	10.7
Minimum Value	0
Standard Deviation of the Mean	0.41

FIGURE 5-27

HISTOGRAMS FOR SMOOTH LONGITUDINAL CENTER SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-DEGAS-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
106	1	X
119	2	XX
132	1	X
145	10	XXXXXXXXXX
158	14	XXXXXXXXXXXXXX
170	19	XXXXXXXXXXXXXXXXXXX
183	24	XXXXXXXXXXXXXXXXXXXXXXXX
196	19	XXXXXXXXXXXXXXXXXXX
209	31	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
222	23	XXXXXXXXXXXXXXXXXXXXXXX
235	36	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
248	41	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
261	33	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
274	16	XXXXXXXXXXXXXXXX
287	12	XXXXXXXXXXXX
300	5	XXXXX
312	0	
325	1	X

Number of Tests	288
Arithmetic Mean	221.9
Standard Deviation	40.5
Maximum Value	318.9
Minimum Value	99.4
Standard Deviation of the Mean	2.39

Class Mid-Point N/S Ratio	Frequency	
.408	2	XX
.445	1	X
.481	6	XXXXXX
.518	10	XXXXXXXXXX
.554	10	XXXXXXXXXX
.591	15	XXXXXXXXXXXXXXX
.627	23	XXXXXXXXXXXXXXXXXXXXXXX
.664	28	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
.700	18	XXXXXXXXXXXXXXXXXX
.736	23	XXXXXXXXXXXXXXXXXXXXXXX
.773	34	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.809	21	XXXXXXXXXXXXXXXXXXXXX
.846	26	XXXXXXXXXXXXXXXXXXXXXXXXXX
.882	36	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.919	12	XXXXXXXXXXXX
.955	15	XXXXXXXXXXXXXXX
.992	3	XXX
1.03	1	X

Number of Tests	284
Arithmetic Mean	0.75
Standard Deviation	0.131
Maximum Value	1.01
Minimum Value	0.39
Standard Deviation of the Mean	0.0078

FIGURE 5-28

HISTOGRAMS FOR NOTCHED SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-DEGAS-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
106	1	X
119	2	XX
132	1	X
146	11	XXXXXXXXXXX
159	12	XXXXXXXXXXXX
172	18	XXXXXXXXXXXXXXXXXX
185	21	XXXXXXXXXXXXXXXXXXXXX
198	14	XXXXXXXXXXXXXX
212	26	XXXXXXXXXXXXXXXXXXXXXXXXXX
225	13	XXXXXXXXXXXXX
238	18	XXXXXXXXXXXXXXXXXX
251	20	XXXXXXXXXXXXXXXXXXXX
264	15	XXXXXXXXXXXXXXX
278	3	XXX
291	1	X

Number of Tests	176
Arithmetic Mean	207.8
Standard Deviation	38.9
Maximum Value	284.2
Minimum Value	99.4
Standard Deviation of the Mean	2.93

Class Mid-Point N/S Ratio	Frequency	
.412	3	XXX
.455	2	XX
.499	13	XXXXXXXXXXXXX
.542	6	XXXXXX
.586	18	XXXXXXXXXXXXXXXXXX
.630	22	XXXXXXXXXXXXXXXXXXXXXX
.673	19	XXXXXXXXXXXXXXXXXXX
.717	14	XXXXXXXXXXXXXX
.760	19	XXXXXXXXXXXXXXXXXXX
.804	19	XXXXXXXXXXXXXXXXXXX
.847	16	XXXXXXXXXXXXXXXX
.891	15	XXXXXXXXXXXXXXX
.935	7	XXXXXXX
.978	2	XX
1.02	1	X

Number of Tests	176
Arithmetic Mean	0.71
Standard Deviation	0.134
Maximum Value	1.00
Minimum Value	0.39
Standard Deviation of the Mean	0.0101

FIGURE 5-29

HISTOGRAMS FOR NOTCHED TRANSVERSE SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-DEGAS-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
150	2	XX
168	1	X
186	0	
204	3	XXX
222	5	XXXXX
239	14	XXXXXXXXXXXXXX
257	15	XXXXXXXXXXXXXXX
275	7	XXXXXXX
293	1	X

Number of Tests	48
Arithmetic Mean	241.7
Standard Deviation	30.4
Maximum Value	284.2
Minimum Value	141.0
Standard Deviation of the Mean	4.39

Class Mid-Point N/S Ratio	Frequency	
.541	1	X
.602	4	XXXX
.663	3	XXX
.724	0	
.786	9	XXXXXXXXX
.847	16	XXXXXXXXXXXXXXXX
.908	10	XXXXXXXXXX
.969	4	XXXX
1.03	1	X

Number of Tests	48
Arithmetic Mean	0.82
Standard Deviation	0.109
Maximum Value	1.00
Minimum Value	0.51
Standard Deviation of the Mean	0.0157

FIGURE 5-30

HISTOGRAMS FOR NOTCHED TRANSVERSE SURFACE SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-DEGAS-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
107	1	X
122	0	
138	0	
153	10	XXXXXXXXXX
168	15	XXXXXXXXXXXXXXX
183	13	XXXXXXXXXXXXX
198	12	XXXXXXXXXXXX
214	21	XXXXXXXXXXXXXXXXXXXXX
229	6	XXXXXX
244	11	XXXXXXXXXXX
259	6	XXXXXX
275	1	X

Number of Tests	96
Arithmetic Mean	201.2
Standard Deviation	33.9
Maximum Value	267.1
Minimum Value	99.4
Standard Deviation of the Mean	3.46

Class Mid-Point N/S Ratio	Frequency	
.416	3	XXX
.468	4	XXXX
.520	8	XXXXXXXX
.571	11	XXXXXXXXXXX
.623	9	XXXXXXXXX
.675	19	XXXXXXXXXXXXXXXXXXX
.727	12	XXXXXXXXXXXX
.779	13	XXXXXXXXXXXXX
.830	8	XXXXXXXX
.882	5	XXXXX
.934	3	XXX
.986	1	X

Number of Tests	96
Arithmetic Mean	0.69
Standard Deviation	0.128
Maximum Value	0.96
Minimum Value	0.39
Standard Deviation of the Mean	0.0131

FIGURE 5-31

HISTOGRAMS FOR NOTCHED TRANSVERSE MID-RADIUS SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-DEGAS-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
124	2	XX
136	1	X
149	4	XXXX
161	3	XXX
174	6	XXXXXX
186	6	XXXXXX
199	5	XXXXX
211	4	XXXX
224	1	X

Number of Tests	32
Arithmetic Mean	176.6
Standard Deviation	26.6
Maximum Value	217.7
Minimum Value	117.5
Standard Deviation of the Mean	4.71

Class Mid-Point N/S Ratio	Frequency	
.501	4	XXXX
.542	0	
.583	7	XXXXXXX
.624	8	XXXXXXXX
.666	6	XXXXXX
.707	2	XX
.748	2	XX
.789	2	XX
.831	1	X

Number of Tests	32
Arithmetic Mean	0.63
Standard Deviation	0.080
Maximum Value	0.81
Minimum Value	0.48
Standard Deviation of the Mean	0.0142

FIGURE 5-32

HISTOGRAMS FOR NOTCHED TRANSVERSE CENTER SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-DEGAS-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
157	2	XX
169	0	
181	3	XXX
193	7	XXXXXXX
205	4	XXXX
217	10	XXXXXXXXXX
229	12	XXXXXXXXXXXX
241	18	XXXXXXXXXXXXXXXXXX
253	21	XXXXXXXXXXXXXXXXXXXXX
265	11	XXXXXXXXXXX
277	14	XXXXXXXXXXXXXX
289	5	XXXXX
301	4	XXXX
313	0	
325	1	X

Number of Tests	112
Arithmetic Mean	244.1
Standard Deviation	32.4
Maximum Value	318.9
Minimum Value	151.2
Standard Deviation of the Mean	3.06

Class Mid-Point N/S Ratio	Frequency	
.595	4	XXXX
.626	3	XXX
.657	6	XXXXXX
.687	5	XXXXX
.718	8	XXXXXXXX
.749	8	XXXXXXXX
.780	14	XXXXXXXXXXXXXX
.810	8	XXXXXXXX
.841	7	XXXXXXX
.872	13	XXXXXXXXXXXXX
.902	16	XXXXXXXXXXXXXXXX
.933	8	XXXXXXXX
.964	5	XXXXX
.995	2	XX
1.03	1	X

Number of Tests	108
Arithmetic Mean	0.81
Standard Deviation	0.102
Maximum Value	1.01
Minimum Value	0.58
Standard Deviation of the Mean	0.0098

FIGURE 5-33

HISTOGRAMS FOR NOTCHED LONGITUDINAL SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-DEGAS-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
196	1	X
212	1	X
229	4	XXXX
245	7	XXXXXXX
261	6	XXXXXX
278	8	XXXXXXXX
294	3	XXX
311	0	
327	1	X

Number of Tests	31
Arithmetic Mean	258.7
Stardard Deviation	26.8
Maximum Value	318.9
Minimum Value	187.5
Standard Deviation of the Mean	4.82

Class Mid-Point N/S Ratio	Frequency	
.701	1	X
.742	0	
.783	4	XXXX
.824	4	XXXX
.866	6	XXXXXX
.907	6	XXXXXX
.948	6	XXXXXX
.989	3	XXX
1.03	1	X

Number of Tests	31
Arithmetic Mean	0.88
Standard Deviation	0.074
Maximum Value	1.01
Minimum Value	0.68
Standard Deviation of the Mean	0.0133

FIGURE 5-34

HISTOGRAMS FOR NOTCHED LONGITUDINAL SURFACE SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-DEGAS-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
188	2	XX
203	2	XX
219	4	XXXX
235	6	XXXXXX
250	12	XXXXXXXXXXXX
266	12	XXXXXXXXXXXX
281	7	XXXXXXX
297	2	XX
313	1	X

Number of Tests	48
Arithmetic Mean	251.8
Standard Deviation	26.6
Maximum Value	304.9
Minimum Value	180.0
Standard Deviation of the Mean	3.83

Class Mid-Point N/S Ratio	Frequency	
.631	4	XXXX
.674	1	X
.716	2	XX
.759	3	XXX
.801	11	XXXXXXXXXXX
.844	6	XXXXXX
.886	14	XXXXXXXXXXXXXX
.929	5	XXXXX
.971	1	X

Number of Tests	47
Arithmetic Mean	0.82
Standard Deviation	0.089
Maximum Value	0.95
Minimum Value	0.61
Standard Deviation of the Mean	0.0129

FIGURE 5-35

HISTOGRAMS FOR NOTCHED LONGITUDINAL MID-RADIUS SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-DEGAS-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
160	2	XX
179	4	XXXX
197	5	XXXXX
216	7	XXXXXXX
234	8	XXXXXXXX
253	4	XXXX
271	1	X
290	0	
308	1	X

Number of Tests	32
Arithmetic Mean	218.7
Standard Deviation	31.9
Maximum Value	299.0
Minimum Value	151.2
Standard Deviation of the Mean	5.64

Class Mid-Point N/S Ratio	Frequency	
.600	2	XX
.640	6	XXXXXX
.680	3	XXX
.720	7	XXXXXXX
.760	6	XXXXXX
.800	4	XXXX
.840	0	
.880	0	
.920	1	X

Number of Tests	29
Arithmetic Mean	0.71
Standard Deviation	0.069
Maximum Value	0.90
Minimum Value	0.58
Standard Deviation of the Mean	0.0129

FIGURE 5-36

HISTOGRAMS FOR NOTCHED LONGITUDINAL CENTER SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-DEGAS-VAR BILLET

SECTION 3

HISTOGRAMS FOR AIR MELT-DOUBLE VACUUM ARC REMELT H-11 STEEL HEAT NO. W-24341-2

Class Mid-Point F_{tu} Ksi	Frequency	
192	1	X
199	0	
205	0	
212	0	
219	0	
225	1	X
232	1	X
239	1	X
245	1	X
252	4	XXXX
259	1	X
265	10	XXXXXXXXXX
272	14	XXXXXXXXXXXXXX
279	30	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
285	79	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
292	140	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
299	193	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
305	119	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
312	35	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
319	7	XXXXXXX
325	1	X

Number of Tests	638
Arithmetic Mean	294.7
Standard Deviation	12.3
Maximum Value	322.0
Minimum Value	188.5
Standard Deviation of the Mean	0.49

Class Mid-Point % R.A.	Frequency	
0.6	20	XXXXXXXXXXXXXXXXXXXX
1.8	71	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
3.0	124	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
4.2	144	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
5.4	92	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
6.6	59	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
7.8	26	XXXXXXXXXXXXXXXXXXXXXXXXXX
9.0	34	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
10.2	20	XXXXXXXXXXXXXXXXXXXX
11.4	11	XXXXXXXXXXX
12.7	11	XXXXXXXXXXX
13.9	3	XXX
15.1	7	XXXXXXX
16.3	2	XX
17.5	2	XX
18.7	6	XXXXXX
19.9	2	XX
21.1	0	
22.3	1	X
23.5	0	
24.7	1	X

Number of Tests	636
Arithmetic Mean	5.4
Standard Deviation	3.5
Maximum Value	24.1
Minimum Value	0
Standard Deviation of the Mean	0.138

FIGURE 5-37

HISTOGRAMS FOR SMOOTH SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-DOUBLE VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
192	1	X
200	0	
207	0	
215	0	
223	1	X
230	1	X
238	0	
245	1	X
253	4	XXXX
260	3	XXX
268	11	XXXXXXXXXXX
275	27	XXXXXXXXXXXXXXXXXXXXXXXXXXX
283	54	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
291	107	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
298	135	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
306	42	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
313	10	XXXXXXXXXX
321	1	X

Number of Tests	398
Arithmetic Mean	291.3
Standard Deviation	12.8
Maximum Value	317.1
Minimum Value	188.5
Standard Deviation of the Mean	0.64

Class Mid-Point % R.A.	Frequency	
0.4	5	XXXXX
1.2	21	XXXXXXXXXXXXXXXXXXXXX
2.0	48	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
2.8	77	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
3.6	76	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
4.3	66	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
5.1	47	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
5.9	22	XXXXXXXXXXXXXXXXXXXXXX
6.7	13	XXXXXXXXXXXXX
7.5	6	XXXXXX
8.3	5	XXXXX
9.1	3	XXX
9.9	2	XX
10.6	0	
11.4	2	XX
12.2	0	
13.0	2	XX
13.8	1	X

Number of Tests	396
Arithmetic Mean	4.0
Standard Deviation	1.9
Maximum Value	13.4
Minimum Value	0
Standard Deviation of the Mean	0.098

FIGURE 5-38

HISTOGRAMS FOR SMOOTH TRANSVERSE SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-DOUBLE VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
193	1	X
202	0	
211	0	
219	0	
228	1	X
237	0	
246	0	
255	2	XX
264	5	XXXXX
273	5	XXXXX
281	19	XXXXXXXXXXXXXXXXXXX
290	39	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
299	63	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
308	8	XXXXXXXX
317	1	X

Number of Tests	144
Arithmetic Mean	290.7
Standard Deviation	14.3
Maximum Value	312.5
Minimum Value	188.5
Standard Deviation of the Mean	1.19

Class Mid-Point % R.A.	Frequency	
1.3	7	XXXXXXX
2.2	16	XXXXXXXXXXXXXXXX
3.1	24	XXXXXXXXXXXXXXXXXXXXXXXX
4.0	30	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
4.9	23	XXXXXXXXXXXXXXXXXXXXXXX
5.8	13	XXXXXXXXXXXXX
6.7	12	XXXXXXXXXXXX
7.6	4	XXXX
8.5	5	XXXXX
9.4	2	XX
10.2	2	XX
11.1	2	XX
12.0	0	
12.9	2	XX
13.8	1	X

Number of Tests	143
Arithmetic Mean	4.6
Standard Deviation	2.4
Maximum Value	13.4
Minimum Value	0.8
Standard Deviation of the Mean	0.20

FIGURE 5-39

HISTOGRAMS FOR SMOOTH TRANSVERSE SURFACE SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-DOUBLE VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
225	1	X
231	0	
236	0	
242	0	
248	1	X
253	0	
259	0	
264	4	XXXX
270	5	XXXXX
275	11	XXXXXXXXXXX
281	15	XXXXXXXXXXXXXXX
286	44	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
292	40	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
298	61	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
303	17	XXXXXXXXXXXXXXXXX
309	18	XXXXXXXXXXXXXXXXXX
314	5	XXXXX
320	1	X

Number of Tests	223
Arithmetic Mean	292.1
Standard Deviation	11.7
Maximum Value	317.1
Minimum Value	222.5
Standard Deviation of the Mean	0.78

Class Mid-Point % R.A.	Frequency	
0.3	3	XXX
0.8	4	XXXX
1.3	9	XXXXXXXXX
1.8	15	XXXXXXXXXXXXXXX
2.4	20	XXXXXXXXXXXXXXXXXXXX
2.9	41	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
3.4	21	XXXXXXXXXXXXXXXXXXXXX
3.9	28	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
4.5	35	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
5.0	16	XXXXXXXXXXXXXXXX
5.5	12	XXXXXXXXXXXX
6.0	8	XXXXXXXX
6.5	3	XXX
7.1	6	XXXXXX
7.6	0	
8.1	0	
8.6	0	
9.2	1	X

Number of Tests	222
Arithmetic Mean	3.7
Standard Deviation	1.5
Maximum Value	8.9
Minimum Value	0
Standard Deviation of the Mean	0.997

FIGURE 5-40

HISTOGRAMS FOR SMOOTH TRANSVERSE MID-RADIUS SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-DOUBLE VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
253	2	XX
260	0	
267	0	
274	2	XX
281	6	XXXXXX
288	4	XXXX
295	8	XXXXXXXX
302	8	XXXXXXXX
308	1	X

Number of Tests	31
Arithmetic Mean	288.9
Standard Deviation	12.9
Maximum Value	305.0
Minimum Value	249.8
Standard Deviation of the Mean	2.32

Class Mid-Point % R.A.	Frequency	
0.3	1	X
0.9	3	XXX
1.6	2	XX
2.2	5	XXXXX
2.8	6	XXXXXX
3.4	3	XXX
4.1	4	XXXX
4.7	4	XXXX
5.3	3	XXX

Number of Tests	31
Arithmetic Mean	3.0
Standard Deviation	1.4
Maximum Value	5.0
Minimum Value	0
Standard Deviation of the Mean	0.25

FIGURE 5-41

HISTOGRAMS FOR SMOOTH TRANSVERSE CENTER SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-DOUBLE VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
238	1	X
243	0	
248	0	
253	0	
259	0	
264	1	X
269	1	X
274	1	X
279	1	X
284	6	XXXXXX
289	12	XXXXXXXXXXXX
294	40	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
299	65	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
304	65	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
309	35	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
314	9	XXXXXXXXX
319	2	XX
325	1	X

Number of Tests	240
Arithmetic Mean	300.3
Standard Deviation	8.9
Maximum Value	322.0
Minimum Value	235.7
Standard Deviation of the Mean	0.57

Class Mid-Point % R.A.	Frequency	
1.5	5	XXXXX
2.9	18	XXXXXXXXXXXXXXXXXX
4.2	43	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
5.6	41	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
7.0	34	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
8.3	25	XXXXXXXXXXXXXXXXXXXXXXXXX
9.7	22	XXXXXXXXXXXXXXXXXXXXXX
11.1	16	XXXXXXXXXXXXXXXX
12.4	13	XXXXXXXXXXXXX
13.8	4	XXXX
15.2	5	XXXXX
16.6	2	XX
17.9	7	XXXXXXX
19.3	2	XX
20.7	1	X
22.0	1	X
23.4	0	
24.8	1	X

Number of Tests	240
Arithmetic Mean	7.8
Standard Deviation	4.1
Maximum Value	24.1
Minimum Value	0.8
Standard Deviation of the Mean	0.27

FIGURE 5-42

HISTOGRAMS FOR SMOOTH LONGITUDINAL SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-DOUBLE VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
284	1	X
287	3	XXX
289	1	X
291	2	XX
294	6	XXXXXX
296	7	XXXXXXX
298	11	XXXXXXXXXXX
301	13	XXXXXXXXXXXXX
303	12	XXXXXXXXXXXX
305	6	XXXXXX
308	1	X
310	1	X

Number of Tests	64
Arithmetic Mean	298.8
Standard Deviation	5.3
Maximum Value	308.8
Minimum Value	283.0
Standard Deviation of the Mean	0.66

Class Mid-Point % R.A.	Frequency	
2.2	3	XXX
4.2	11	XXXXXXXXXXX
6.3	15	XXXXXXXXXXXXXXX
8.4	9	XXXXXXXXX
10.5	6	XXXXXX
12.6	8	XXXXXXXX
14.7	3	XXX
16.8	1	X
18.9	5	XXXXX
21.0	2	XX
23.1	0	
25.1	1	X

Number of Tests	64
Arithmetic Mean	9.5
Standard Deviation	5.3
Maximum Value	24.1
Minimum Value	1.1
Standard Deviation of the Mean	0.66

FIGURE 5-43

HISTOGRAMS FOR SMOOTH LONGITUDINAL SURFACE SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-DOUBLE VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
239	1	X
245	0	
251	0	
257	0	
263	1	X
270	0	
276	1	X
282	4	XXXX
288	5	XXXXX
294	22	XXXXXXXXXXXXXXXXXXXXXX
300	46	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
307	46	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
313	13	XXXXXXXXXXXXX
319	4	XXXX
325	1	X

Number of Tests	144
Arithmetic Mean	301.4
Standard Deviation	10.0
Maximum Value	322.0
Minimum Value	235.7
Standard Deviation of the Mean	0.84

Class Mid-Point % R.A.	Frequency	
1.5	3	XXX
2.8	8	XXXXXXXX
4.1	33	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
5.4	21	XXXXXXXXXXXXXXXXXXXXX
6.7	24	XXXXXXXXXXXXXXXXXXXXXXXX
8.0	15	XXXXXXXXXXXXXXX
9.3	10	XXXXXXXXXX
10.7	13	XXXXXXXXXXXXX
12.0	4	XXXX
13.3	4	XXXX
14.6	4	XXXX
15.9	1	X
17.2	2	XX
18.5	1	X
19.9	1	X

Number of Tests	144
Arithmetic Mean	7.2
Standard Deviation	3.6
Maximum Value	19.2
Minimum Value	0.8
Standard Deviation of the Mean	0.30

FIGURE 5-44

HISTOGRAMS FOR SMOOTH LONGITUDINAL MID-RADIUS SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-DOUBLE VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
273	1	X
278	1	X
284	0	
290	1	X
295	12	XXXXXXXXXXXX
301	10	XXXXXXXXXX
307	5	XXXXX
312	1	X
318	1	X

Number of Tests	32
Arithmetic Mean	298.6
Standard Deviation	8.4
Maximum Value	315.0
Minimum Value	270.0
Standard Deviation of the Mean	1.48

Class Mid-Point % R.A.	Frequency	
3.3	1	X
4.4	9	XXXXXXXXX
5.8	4	XXXX
6.7	5	XXXXX
7.9	3	XXX
9.0	6	XXXXXX
10.2	2	XX
11.3	1	X
12.5	1	X

Number of Tests	32
Arithmetic Mean	6.7
Standard Deviation	2.4
Maximum Value	11.9
Minimum Value	2.7
Standard Deviation of the Mean	0.42

FIGURE 5-45

HISTOGRAMS FOR SMOOTH LONGITUDINAL CENTER SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- AIR MELT-DOUBLE VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
107	3	XXX
119	3	XXX
131	5	XXXXX
142	1	X
154	9	XXXXXXXXX
166	10	XXXXXXXXXX
178	13	XXXXXXXXXXXXX
189	17	XXXXXXXXXXXXXXXXX
201	17	XXXXXXXXXXXXXXXXX
213	16	XXXXXXXXXXXXXXXX
224	29	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
236	47	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
248	40	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
260	31	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
271	26	XXXXXXXXXXXXXXXXXXXXXXXXXX
283	13	XXXXXXXXXXXXX
295	7	XXXXXXX
307	1	X

Number of Tests	288
Arithmetic Mean	227.5
Standard Deviation	40.6
Maximum Value	300.7
Minimum Value	101.3
Standard Deviation of the Mean	2.39

Class Mid-Point N/S Ratio	Frequency	
.383	5	XXXXX
.430	5	XXXXX
.476	2	XX
.523	9	XXXXXXXXX
.569	14	XXXXXXXXXXXXXX
.616	9	XXXXXXXXX
.662	20	XXXXXXXXXXXXXXXXXXXX
.709	25	XXXXXXXXXXXXXXXXXXXXXXXXX
.755	37	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.801	47	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.848	50	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.894	28	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
.941	27	XXXXXXXXXXXXXXXXXXXXXXXXXXX
.987	6	XXXXXX
1.03	0	
1.08	2	XX
1.13	0	
1.17	1	X

Number of Tests	287
Arithmetic Mean	0.77
Standard Deviation	0.137
Maximum Value	1.15
Minimum Value	0.36
Standard Deviation of the Mean	0.0081

FIGURE 5-46

HISTOGRAMS FOR NOTCHED SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-DOUBLE VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
108	5	XXXXX
122	2	XX
135	4	XXXX
149	7	XXXXXXX
163	8	XXXXXXXX
176	15	XXXXXXXXXXXXXXX
190	16	XXXXXXXXXXXXXXXX
204	17	XXXXXXXXXXXXXXXXX
217	17	XXXXXXXXXXXXXXXXX
231	27	XXXXXXXXXXXXXXXXXXXXXXXXXXX
245	26	XXXXXXXXXXXXXXXXXXXXXXXXXX
258	17	XXXXXXXXXXXXXXXXX
272	11	XXXXXXXXXXX
285	3	XXX
299	1	X

Number of Tests	176
Arithmetic Mean	213.6
Standard Deviation	41.5
Maximum Value	292.3
Minimum Value	101.3
Standard Deviation of the Mean	3.13

Class Mid-Point N/S Ratio	Frequency	
.388	5	XXXXX
.445	6	XXXXXX
.501	3	XXX
.557	13	XXXXXXXXXXXXX
.614	17	XXXXXXXXXXXXXXXXX
.670	19	XXXXXXXXXXXXXXXXXXX
.727	22	XXXXXXXXXXXXXXXXXXXXXX
.783	34	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.840	22	XXXXXXXXXXXXXXXXXXXXXX
.896	21	XXXXXXXXXXXXXXXXXXXXX
.952	11	XXXXXXXXXXX
1.01	0	
1.07	1	X
1.12	0	
1.18	1	X

Number of Tests	175
Arithmetic Mean	0.74
Standard Deviation	0.146
Maximum Value	1.15
Minimum Value	0.36
Standard Deviation of the Mean	0.0110

FIGURE 5-47

HISTOGRAMS FOR NOTCHED TRANSVERSE SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-DOUBLE VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
184	3	XXX
198	3	XXX
213	4	XXXX
227	10	XXXXXXXXXX
242	12	XXXXXXXXXXXX
256	12	XXXXXXXXXXXX
271	2	XX
285	1	X
300	1	X

Number of Tests	48
Arithmetic Mean	235.8
Standard Deviation	25.1
Maximum Value	292.3
Minimum Value	176.8
Standard Deviation of the Mean	3.62

Class Mid-Point N/S Ratio	Frequency	
.619	2	XX
.678	3	XXX
.737	7	XXXXXXX
.796	12	XXXXXXXXXXXX
.854	17	XXXXXXXXXXXXXXXXX
.913	2	XX
.972	4	XXXX
1.03	0	
1.09	1	X

Number of Tests	48
Arithmetic Mean	0.81
Standard Deviation	0.090
Maximum Value	1.06
Minimum Value	0.59
Standard Deviation of the Mean	0.0130

FIGURE 5-48

HISTOGRAMS FOR NOTCHED TRANSVERSE SURFACE SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-DOUBLE VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
121	4	XXXX
137	1	X
152	5	XXXXX
167	6	XXXXXX
183	14	XXXXXXXXXXXXXX
198	12	XXXXXXXXXXXX
214	8	XXXXXXXX
229	14	XXXXXXXXXXXXXX
244	14	XXXXXXXXXXXXXX
260	8	XXXXXXXX
275	9	XXXXXXXXX
291	1	X

Number of Tests	96
Arithmetic Mean	213.2
Standard Deviation	41.2
Maximum Value	282.9
Minimum Value	113.4
Standard Deviation of the Mean	4.20

Class Mid-Point N/S Ratio	Frequency	
.405	4	XXXX
.476	2	XX
.547	8	XXXXXXXX
.618	16	XXXXXXXXXXXXXXXX
.689	14	XXXXXXXXXXXXXX
.760	20	XXXXXXXXXXXXXXXXXXXX
.831	13	XXXXXXXXXXXXX
.902	13	XXXXXXXXXXXXX
.973	5	XXXXX
1.04	0	
1.11	0	
1.19	1	X

Number of Tests	96
Arithmetic Mean	0.73
Standard Deviation	0.146
Maximum Value	1.15
Minimum Value	0.37
Standard Deviation of the Mean	0.0149

FIGURE 5-49

HISTOGRAMS FOR NOTCHED TRANSVERSE MID-RADIUS SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-DOUBLE VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
111	3	XXX
131	3	XXX
151	4	XXXX
171	5	XXXXX
191	7	XXXXXXX
211	4	XXXX
231	3	XXX
251	2	XX
271	1	X

Number of Tests	32
Arithmetic Mean	182.0
Standard Deviation	42.2
Maximum Value	260.8
Minimum Value	101.3
Standard Deviation of the Mean	7.46

Class Mid-Point N/S Ratio	Frequency	
.395	3	XXX
.465	3	XXX
.535	3	XXX
.605	5	XXXXX
.675	7	XXXXXXX
.745	5	XXXXX
.815	4	XXXX
.885	0	
.955	1	X

Number of Tests	31
Arithmetic Mean	0.63
Standard Deviation	0.147
Maximum Value	0.92
Minimum Value	0.36
Standard Deviation of the Mean	0.0264

FIGURE 5-50

HISTOGRAMS FOR NOTCHED TRANSVERSE CENTER SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-DOUBLE VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
159	2	XX
169	0	
180	1	X
190	2	XX
201	1	X
211	4	XXXX
222	9	XXXXXXXXX
232	13	XXXXXXXXXXXXX
243	19	XXXXXXXXXXXXXXXXXXX
253	17	XXXXXXXXXXXXXXXXX
264	18	XXXXXXXXXXXXXXXXXX
274	12	XXXXXXXXXXXX
285	10	XXXXXXXXXX
295	3	XXX
306	1	X

Number of Tests	112
Arithmetic Mean	249.4
Standard Deviation	27.4
Maximum Value	300.7
Minimum Value	153.3
Standard Deviation of the Mean	2.59

Class Mid-Point N/S Ratio	Frequency	
.521	1	X
.564	1	X
.607	1	X
.650	1	X
.693	5	XXXXX
.736	11	XXXXXXXXXXX
.779	21	XXXXXXXXXXXXXXXXXXXXX
.821	22	XXXXXXXXXXXXXXXXXXXXXX
.864	14	XXXXXXXXXXXXXX
.907	16	XXXXXXXXXXXXXXXX
.950	14	XXXXXXXXXXXXXX
.993	4	XXXX
1.04	0	
1.08	0	
1.12	1	X

Number of Tests	112
Arithmetic Mean	0.83
Standard Deviation	0.095
Maximum Value	1.10
Minimum Value	0.50
Standard Deviation of the Mean	0.0090

FIGURE 5-51

HISTOGRAMS FOR NOTCHED LONGITUDINAL SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-DOUBLE VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
217	4	XXXX
228	3	XXX
238	2	XX
249	5	XXXXX
259	4	XXXX
270	7	XXXXXXX
281	2	XX
291	4	XXXX
302	1	X

Number of Tests	32
Arithmetic Mean	257.0
Standard Deviation	24.0
Maximum Value	296.3
Minimum Value	212.1
Standard Deviation of the Mean	4.24

Class Mid-Point N/S Ratio	Frequency	
.753	5	XXXXX
.799	6	XXXXXX
.846	5	XXXXX
.892	7	XXXXXXX
.938	6	XXXXXX
.984	2	XX
1.03	0	
1.08	0	
1.12	1	X

Number of Tests	32
Arithmetic Mean	0.86
Standard Deviation	0.087
Maximum Value	1.10
Minimum Value	0.73
Standard Deviation of the Mean	0.0154

FIGURE 5-52

HISTOGRAMS FOR NOTCHED LONGITUDINAL SURFACE SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-DOUBLE VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
163	1	X
181	0	
199	1	X
218	1	X
236	13	XXXXXXXXXXXXX
255	16	XXXXXXXXXXXXXXXX
273	10	XXXXXXXXXX
291	5	XXXXX
310	1	X

Number of Tests	48
Arithmetic Mean	255.0
Standard Deviation	25.0
Maximum Value	300.7
Minimum Value	153.3
Standard Deviation of the Mean	3.61

Class Mid-Point N/S Ratio	Frequency	
.532	1	X
.596	0	
.659	0	
.723	2	XX
.787	14	XXXXXXXXXXXXXX
.851	16	XXXXXXXXXXXXXXXX
.914	7	XXXXXXX
.978	6	XXXXXX
1.04	2	XX

Number of Tests	48
Arithmetic Mean	0.85
Standard Deviation	0.089
Maximum Value	1.01
Minimum Value	0.50
Standard Deviation of the Mean	0.0129

FIGURE 5-53

HISTOGRAMS FOR NOTCHED LONGITUDINAL MID-RADIUS SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-DOUBLE VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
170	1	X
186	3	XXX
202	1	X
218	6	XXXXXX
234	9	XXXXXXXXX
250	4	XXXX
266	7	XXXXXXX
282	0	
297	1	X

Number of Tests	32
Arithmetic Mean	233.3
Standard Deviation	28.1
Maximum Value	289.5
Minimum Value	162.1
Standard Deviation of the Mean	4.96

Class Mid-Point N/S Ratio	Frequency	
.576	1	X
.629	2	XX
.681	3	XXX
.734	6	XXXXXX
.786	9	XXXXXXXXX
.839	3	XXX
.891	7	XXXXXXX
.944	0	
.996	1	X

Number of Tests	32
Arithmetic Mean	0.78
Standard Deviation	0.093
Maximum Value	0.97
Minimum Value	0.55
Standard Deviation of the Mean	0.0163

FIGURE 5-54

HISTOGRAMS FOR NOTCHED LONGITUDINAL CENTER SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- AIR MELT-DOUBLE VAR BILLET

SECTION 4

HISTOGRAMS FOR VACUUM INDUCTION MELT-VACUUM ARC REMELT H-11 STEEL HEAT NO. W-24403-1

Class Mid-Point F_{tu} Ksi	Frequency	
259	1	X
262	0	
265	0	
268	1	X
271	0	
274	1	X
277	1	X
281	4	XXXX
284	13	XXXXXXXXXXXXX
287	29	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
290	131	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
293	172	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
296	163	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
299	83	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
302	20	XXXXXXXXXXXXXXXXXXXX
306	9	XXXXXXXXX
209	10	XXXXXXXXXX
312	0	
315	0	
318	1	X
321	1	X

Number of Tests	640
Arithmetic Mean	294.2
Standard Deviation	5.2
Maximum Value	319.7
Minimum Value	257.1
Standard Deviation of the Mean	0.21

Class Mid-Point % R.A.	Frequency	
2.0	1	X
3.3	14	XXXXXXXXXXXXXX
4.6	11	XXXXXXXXXXX
5.8	19	XXXXXXXXXXXXXXXXXXX
7.1	28	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
8.3	46	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
9.6	55	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
10.8	52	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
12.1	77	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
13.4	69	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
14.6	61	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
15.9	45	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
17.1	51	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
18.4	41	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
19.7	32	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
20.9	16	XXXXXXXXXXXXXXXX
22.2	8	XXXXXXXX
23.4	7	XXXXXXX
24.7	2	XX
26.0	4	XXXX
27.2	1	X

Number of Tests	640
Arithmetic Mean	13.2
Standard Deviation	4.63
Maximum Value	26.6
Minimum Value	1.4
Standard Deviation of the Mean	0.183

FIGURE 5-55

HISTOGRAMS FOR SMOOTH SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- VACUUM INDUCTION MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
259	1	X
262	0	
265	0	
268	1	X
271	0	
274	1	X
277	1	X
281	2	XX
284	7	XXXXXXX
287	19	XXXXXXXXXXXXXXXXXXX
290	91	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
293	108	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
296	101	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
299	48	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
302	13	XXXXXXXXXXXXX
306	4	XXXX
309	1	X
312	0	
315	0	
318	1	X
321	1	X

Number of Tests	400
Arithmetic Mean	293.7
Standard Deviation	5.20
Maximum Value	319.7
Minimum Value	257.1
Standard Deviation of the Mean	0.260

Class Mid-Point % R.A.	Frequency	
2.0	1	X
3.2	10	XXXXXXXXXX
4.5	14	XXXXXXXXXXXXXX
5.7	13	XXXXXXXXXXXXX
6.9	19	XXXXXXXXXXXXXXXXXXX
8.1	23	XXXXXXXXXXXXXXXXXXXXXXX
9.3	31	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
10.5	31	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
11.8	36	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
13.0	38	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
14.2	40	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
15.4	33	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
16.6	28	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
17.9	36	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
19.1	19	XXXXXXXXXXXXXXXXXXX
20.3	16	XXXXXXXXXXXXXXXX
21.5	4	XXXX
22.7	3	XXX
24.0	3	XXX
25.2	1	X
26.4	1	X

Number of Tests	400
Arithmetic Mean	12.9
Standard Deviation	4.74
Maximum Value	25.8
Minimum Value	1.4
Standard Deviation of the Mean	0.237

FIGURE 5-56

HISTOGRAMS FOR SMOOTH TRANSVERSE SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- VACUUM INDUCTION MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
259	1	X
264	0	
268	1	X
273	1	X
277	1	X
282	2	XX
286	8	XXXXXXXX
291	44	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
295	58	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX→
300	18	XXXXXXXXXXXXXXXXXX
304	8	XXXXXXXX
309	0	
313	0	
317	1	X
322	1	X

Number of Tests	144
Arithmetic Mean	293.7
Standard Deviation	6.94
Maximum Value	319.7
Minimum Value	257.1
Standard Deviation of the Mean	0.58

Class Mid-Point % R.A.	Frequency	
2.3	4	XXXX
4.0	6	XXXXXX
5.8	9	XXXXXXXXX
7.5	13	XXXXXXXXXXXXX
9.2	11	XXXXXXXXXXX
11.0	11	XXXXXXXXXXX
12.7	16	XXXXXXXXXXXXXXXX
14.5	15	XXXXXXXXXXXXXXX
16.2	15	XXXXXXXXXXXXXXX
18.0	13	XXXXXXXXXXXXX
19.7	14	XXXXXXXXXXXXXX
21.4	11	XXXXXXXXXXX
23.2	3	XXX
24.9	2	XX
26.7	1	X

Number of Tests	144
Arithmetic Mean	13.6
Standard Deviation	5.67
Maximum Value	25.8
Minimum Value	1.4
Standard Deviation of the Mean	0.473

FIGURE 5-57

HISTOGRAMS FOR SMOOTH TRANSVERSE SURFACE SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- VACUUM INDUCTION MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
281	1	X
283	1	X
285	1	X
286	2	XX
288	9	XXXXXXXXX
289	18	XXXXXXXXXXXXXXXXXX
291	26	XXXXXXXXXXXXXXXXXXXXXXXXXX
293	35	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
294	26	XXXXXXXXXXXXXXXXXXXXXXXXXX
296	46	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
297	19	XXXXXXXXXXXXXXXXXXX
299	25	XXXXXXXXXXXXXXXXXXXXXXXXX
300	7	XXXXXXX
302	5	XXXXX
304	2	XX
305	0	
307	0	
308	1	X

Number of Tests	224
Arithmetic Mean	294.3
Standard Deviation	3.84
Maximum Value	307.5
Minimum Value	280.7
Standard Deviation of the Mean	0.26

Class Mid-Point % R.A.	Frequency	
3.2	4	XXXX
4.2	1	X
5.3	3	XXX
6.3	10	XXXXXXXXXX
7.3	9	XXXXXXXXX
8.4	6	XXXXXX
9.4	20	XXXXXXXXXXXXXXXXXXXX
10.4	14	XXXXXXXXXXXXXX
11.4	20	XXXXXXXXXXXXXXXXXXXX
12.5	12	XXXXXXXXXXXX
13.5	24	XXXXXXXXXXXXXXXXXXXXXXXX
14.5	23	XXXXXXXXXXXXXXXXXXXXXXX
15.6	16	XXXXXXXXXXXXXXXX
16.6	23	XXXXXXXXXXXXXXXXXXXXXXX
17.6	25	XXXXXXXXXXXXXXXXXXXXXXXXX
18.7	5	XXXXX
19.7	7	XXXXXXX
20.7	2	XX

Number of Tests	224
Arithmetic Mean	13.0
Standard Deviation	3.98
Maximum Value	20.2
Minimum Value	2.7
Standard Deviation of the Mean	0.266

FIGURE 5-58

HISTOGRAMS FOR SMOOTH TRANSVERSE MID-RADIUS SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- VACUUM INDUCTION MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
284	1	X
285	1	X
287	1	X
288	2	XX
290	7	XXXXXXX
291	9	XXXXXXXXX
292	9	XXXXXXXXX
294	1	X
295	1	X

Number of Tests	32
Arithmetic Mean	290.3
Standard Deviation	2.22
Maximum Value	294.2
Minimum Value	283.4
Standard Deviation of the Mean	0.39

Class Mid-Point % R.A.	Frequency	
4.2	5	XXXXX
5.7	3	XXX
7.2	3	XXX
8.6	5	XXXXX
10.1	3	XXX
11.5	5	XXXXX
13.0	5	XXXXX
14.5	2	XX
15.9	1	X

Number of Tests	32
Arithmetic Mean	9.4
Standard Deviation	3.53
Maximum Value	15.2
Minimum Value	3.5
Standard Deviation of the Mean	0.623

FIGURE 5-59

HISTOGRAMS FOR SMOOTH TRANSVERSE CENTER SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- VACUUM INDUCTION MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
282	3	XXX
283	2	XX
285	6	XXXXXX
287	5	XXXXX
289	10	XXXXXXXXXX
290	27	XXXXXXXXXXXXXXXXXXXXXXXXXXX
292	30	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
294	31	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
295	35	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
297	39	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
299	17	XXXXXXXXXXXXXXXXX
300	15	XXXXXXXXXXXXXXX
302	2	XX
304	6	XXXXXX
305	0	
307	6	XXXXXX
309	5	XXXXX
310	1	X

Number of Tests	240
Arithmetic Mean	294.9
Standard Deviation	5.2
Maximum Value	309.6
Minimum Value	281.0
Standard Deviation of the Mean	0.33

Class Mid-Point % R.A.	Frequency	
3.9	1	X
5.3	2	XX
6.6	7	XXXXXXX
8.0	16	XXXXXXXXXXXXXXXX
9.4	29	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
10.8	28	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
12.1	35	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
13.5	35	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
14.9	16	XXXXXXXXXXXXXXXX
16.3	13	XXXXXXXXXXXXX
17.7	15	XXXXXXXXXXXXXXX
19.0	20	XXXXXXXXXXXXXXXXXXXX
20.4	9	XXXXXXXXX
21.8	6	XXXXXX
23.2	4	XXXX
24.5	0	
25.9	3	XXX
27.3	1	X

Number of Tests	240
Arithmetic Mean	13.6
Standard Deviation	4.40
Maximum Value	26.6
Minimum Value	3.2
Standard Deviation of the Mean	0.284

FIGURE 5-60

HISTOGRAMS FOR SMOOTH LONGITUDINAL SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- VACUUM INDUCTION MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
286	2	XX
288	5	XXXXX
291	6	XXXXXX
293	15	XXXXXXXXXXXXXXX
295	11	XXXXXXXXXXX
297	11	XXXXXXXXXXX
300	6	XXXXXX
302	2	XX
304	2	XX
306	0	
308	3	XXX
311	1	X

Number of Tests	64
Arithmetic Mean	295.4
Standard Deviation	5.28
Maximum Value	309.6
Minimum Value	285.0
Standard Deviation of the Mean	0.66

Class Mid-Point % R.A.	Frequency	
10.4	4	XXXX
11.9	0	
13.5	4	XXXX
15.0	7	XXXXXXX
16.6	9	XXXXXXXXX
18.1	13	XXXXXXXXXXXXX
19.6	12	XXXXXXXXXXXX
21.2	4	XXXX
22.7	6	XXXXXX
24.3	1	X
25.8	3	XXX
27.4	1	X

Number of Tests	64
Arithmetic Mean	18.4
Standard Deviation	3.74
Maximum Value	26.6
Minimum Value	9.6
Standard Deviation of the Mean	0.468

FIGURE 5-61

HISTOGRAMS FOR SMOOTH LONGITUDINAL SURFACE SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- VACUUM INDUCTION MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
288	1	X
290	7	XXXXXXX
291	16	XXXXXXXXXXXXXXXX
293	16	XXXXXXXXXXXXXXXX
294	22	XXXXXXXXXXXXXXXXXXXXXX
296	24	XXXXXXXXXXXXXXXXXXXXXXXX
297	21	XXXXXXXXXXXXXXXXXXXXX
299	13	XXXXXXXXXXXXX
300	10	XXXXXXXXXX
302	2	XX
303	2	XX
305	2	XX
306	3	XXX
308	4	XXXX
310	1	X

Number of Tests	144
Arithmetic Mean	296.1
Standard Deviation	4.30
Maximum Value	308.8
Minimum Value	287.2
Standard Deviation of the Mean	0.36

Class Mid-Point % R.A.	Frequency	
3.9	1	X
5.2	2	XX
6.5	4	XXXX
7.8	10	XXXXXXXXXX
9.2	20	XXXXXXXXXXXXXXXXXXXX
10.5	23	XXXXXXXXXXXXXXXXXXXXXXX
11.8	21	XXXXXXXXXXXXXXXXXXXXX
13.1	25	XXXXXXXXXXXXXXXXXXXXXXXXX
14.4	13	XXXXXXXXXXXXX
15.8	12	XXXXXXXXXXXX
17.1	5	XXXXX
18.4	3	XXX
19.7	2	XX
21.0	2	XX
22.4	1	X

Number of Tests	144
Arithmetic Mean	12.1
Standard Deviation	3.34
Maximum Value	21.7
Minimum Value	3.2
Standard Deviation of the Mean	0.278

FIGURE 5-62

HISTOGRAMS FOR SMOOTH LONGITUDINAL MID-RADIUS SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- VACUUM INDUCTION MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
282	3	XXX
284	3	XXX
286	4	XXXX
287	3	XXX
289	7	XXXXXXX
291	9	XXXXXXXXX
293	1	X
295	1	X
297	1	X

Number of Tests	32
Arithmetic Mean	288.4
Standard Deviation	3.62
Maximum Value	295.7
Minimum Value	281.0
Standard Deviation of the Mean	0.64

Class Mid-Point % R.A.	Frequency	
7.1	1	X
8.1	3	XXX
9.1	4	XXXX
10.1	6	XXXXXX
11.0	5	XXXXX
12.0	5	XXXXX
13.0	3	XXX
14.0	4	XXXX
15.0	1	X

Number of Tests	32
Arithmetic Mean	11.0
Standard Deviation	2.05
Maximum Value	14.5
Minimum Value	6.6
Standard Deviation of the Mean	0.362

FIGURE 5-63

HISTOGRAMS FOR SMOOTH LONGITUDINAL CENTER SPECIMEN ULTIMATE STRENGTH AND PER CENT REDUCTION IN AREA -- VACUUM INDUCTION MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
147	1	X
158	2	XX
168	3	XXX
179	2	XX
189	6	XXXXXX
199	10	XXXXXXXXXX
210	22	XXXXXXXXXXXXXXXXXXXXXX
220	42	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
231	34	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
241	32	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
252	36	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
262	28	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
273	20	XXXXXXXXXXXXXXXXXXXX
283	23	XXXXXXXXXXXXXXXXXXXXXXX
294	10	XXXXXXXXXX
304	9	XXXXXXXXX
315	7	XXXXXXX
325	1	X

Number of Tests	288
Arithmetic Mean	244.9
Standard Deviation	32.5
Maximum Value	319.9
Minimum Value	141.9
Standard Deviation of the Mean	1.92

Class Mid-Point N/S Ratio	Frequency	
.498	1	X
.534	2	XX
.570	2	XX
.606	4	XXXX
.641	4	XXXX
.677	12	XXXXXXXXXXXX
.713	24	XXXXXXXXXXXXXXXXXXXXXXXX
.749	31	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.785	36	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.821	32	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.857	38	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.893	39	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.929	16	XXXXXXXXXXXXXXXX
.964	22	XXXXXXXXXXXXXXXXXXXXXX
1.00	11	XXXXXXXXXXX
1.04	10	XXXXXXXXXX
1.07	3	XXX
1.11	1	X

Number of Tests	288
Arithmetic Mean	0.83
Standard Deviation	0.108
Maximum Value	1.09
Minimum Value	0.48
Standard Deviation of the Mean	0.0064

FIGURE 5-64

HISTOGRAMS FOR NOTCHED SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- VACUUM INDUCTION MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
148	1	X
159	2	XX
171	4	XXXX
182	2	XX
194	10	XXXXXXXXXX
205	11	XXXXXXXXXXX
217	32	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
228	28	XXXXXXXXXXXXXXXXXXXXXXXXXXXX
240	24	XXXXXXXXXXXXXXXXXXXXXXXX
251	24	XXXXXXXXXXXXXXXXXXXXXXXX
263	15	XXXXXXXXXXXXXXX
274	10	XXXXXXXXXX
286	9	XXXXXXXXX
297	3	XXX
309	1	X

Number of Tests	176
Arithmetic Mean	234.8
Standard Deviation	29.4
Maximum Value	303.1
Minimum Value	141.9
Standard Deviation of the Mean	2.21

Class Mid-Point N/S Ratio	Frequency	
.500	1	X
.540	2	XX
.580	3	XXX
.620	3	XXX
.660	7	XXXXXXX
.700	11	XXXXXXXXXXX
.740	35	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
.780	24	XXXXXXXXXXXXXXXXXXXXXXXX
.820	25	XXXXXXXXXXXXXXXXXXXXXXXXX
.860	24	XXXXXXXXXXXXXXXXXXXXXXXX
.900	20	XXXXXXXXXXXXXXXXXXXX
.940	10	XXXXXXXXXX
.980	8	XXXXXXXX
1.02	2	XX
1.06	1	X

Number of Tests	176
Arithmetic Mean	0.80
Standard Deviation	0.100
Maximum Value	1.04
Minimum Value	0.48
Standard Deviation of the Mean	0.0075

FIGURE 5-65

HISTOGRAMS FOR NOTCHED TRANSVERSE SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- VACUUM INDUCTION MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
.75	1	X
191	0	
207	5	XXXXX
223	7	XXXXXXX
239	13	XXXXXXXXXXXXX
256	7	XXXXXXX
272	8	XXXXXXXX
288	6	XXXXXX
304	1	X

Number of Tests	48
Arithmetic Mean	246.7
Standard Deviation	26.9
Maximum Value	295.8
Minimum Value	167.0
Standard Deviation of the Mean	3.88

Class Mid-Point N/S Ratio	Frequency	
.597	1	X
.652	0	
.707	7	XXXXXXX
.762	7	XXXXXXX
.817	8	XXXXXXXX
.872	10	XXXXXXXXXX
.927	10	XXXXXXXXXX
.982	4	XXXX
1.04	1	X

Number of Tests	48
Arithmetic Mean	0.84
Standard Deviation	0.095
Maximum Value	1.01
Minimum Value	0.57
Standard Deviation of the Mean	0.0137

FIGURE 5-66

HISTOGRAMS FOR NOTCHED TRANSVERSE SURFACE SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- VACUUM INDUCTION MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
149	1	X
164	1	X
179	3	XXX
193	9	XXXXXXXXX
208	9	XXXXXXXXX
223	20	XXXXXXXXXXXXXXXXXXXX
237	16	XXXXXXXXXXXXXXXX
252	20	XXXXXXXXXXXXXXXXXXXX
266	8	XXXXXXXX
281	6	XXXXXX
296	2	XX
310	1	X

Number of Tests	96
Arithmetic Mean	233.1
Standard Deviation	30.1
Maximum Value	303.1
Minimum Value	141.9
Standard Deviation of the Mean	3.07

Class Mid-Point N/S Ratio	Frequency	
.505	1	X
.556	1	X
.607	3	XXX
.658	8	XXXXXXXX
.709	13	XXXXXXXXXXXXX
.760	21	XXXXXXXXXXXXXXXXXXXXX
.811	14	XXXXXXXXXXXXXX
.862	18	XXXXXXXXXXXXXXXXXX
.913	8	XXXXXXXX
.964	6	XXXXXX
1.01	2	XX
1.07	1	X

Number of Tests	96
Arithmetic Mean	0.79
Standard Deviation	0.102
Maximum Value	1.04
Minimum Value	0.48
Standard Deviation of the Mean	0.0104

FIGURE 5-67

HISTOGRAMS FOR NOTCHED TRANSVERSE MID-RADIUS SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- VACUUM INDUCTION MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
168	3	XXX
183	0	
198	2	XX
213	9	XXXXXXXXX
228	9	XXXXXXXXX
243	6	XXXXXX
258	2	XX
273	0	
288	1	X

Number of Tests	32
Arithmetic Mean	221.8
Standard Deviation	24.5
Maximum Value	280.2
Minimum Value	160.5
Standard Deviation of the Mean	4.32

Class Mid-Point N/S Ratio	Frequency	
.576	3	XXX
.629	0	
.681	2	XX
.734	9	XXXXXXXXX
.786	11	XXXXXXXXXXX
.839	5	XXXXX
.891	1	X
.944	0	
.996	1	X

Number of Tests	32
Arithmetic Mean	0.76
Standard Deviation	0.085
Maximum Value	0.97
Minimum Value	0.55
Standard Deviation	0.0150

FIGURE 5-68

HISTOGRAMS FOR NOTCHED TRANSVERSE CENTER SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- VACUUM INDUCTION MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
191	1	X
201	2	XX
210	6	XXXXXX
220	6	XXXXXX
229	11	XXXXXXXXXXX
239	7	XXXXXXX
248	9	XXXXXXXXX
258	16	XXXXXXXXXXXXXXXX
267	15	XXXXXXXXXXXXXXX
277	10	XXXXXXXXXX
287	8	XXXXXXXX
296	6	XXXXXX
306	7	XXXXXXX
315	7	XXXXXXX
325	1	X

Number of Tests	112
Arithmetic Mean	260.8
Standard Deviation	30.9
Maximum Value	319.9
Minimum Value	186.4
Standard Deviation of the Mean	2.92

Class Mid-Point N/S Ratio	Frequency	
.656	1	X
.688	3	XXX
.720	5	XXXXX
.752	5	XXXXX
.785	14	XXXXXXXXXXXXXX
.817	9	XXXXXXXXX
.849	11	XXXXXXXXXXX
.881	11	XXXXXXXXXXX
.913	13	XXXXXXXXXXXXX
.945	14	XXXXXXXXXXXXXX
.977	8	XXXXXXXX
1.01	8	XXXXXXXX
1.04	6	XXXXXX
1.07	3	XXX
1.11	1	X

Number of Tests	112
Arithmetic Mean	0.88
Standard Deviation	0.101
Maximum Value	1.09
Minimum Value	0.64
Standard Deviation of the Mean	0.0095

FIGURE 5-69

HISTOGRAMS FOR NOTCHED LONGITUDINAL SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- VACUUM INDUCTION MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
226	1	X
238	3	XXX
251	3	XXX
264	6	XXXXXX
276	5	XXXXX
289	4	XXXX
301	4	XXXX
314	5	XXXXX
326	1	X

Number of Tests	32
Arithmetic Mean	278.9
Standard Deviation	26.6
Maximum Value	319.9
Minimum Value	219.7
Standard Deviation of the Mean	4.70

Class Mid-Point N/S Ratio	Frequency	
.771	2	XX
.814	2	XX
.856	2	XX
.899	7	XXXXXXX
.941	6	XXXXXX
.984	4	XXXX
1.03	3	XXX
1.07	5	XXXXX
1.11	1	X

Number of Tests	32
Arithmetic Mean	0.94
Standard Deviation	0.089
Maximum Value	1.09
Minimum Value	0.75
Standard Deviation of the Mean	0.0157

FIGURE 5-70

HISTOGRAMS FOR NOTCHED LONGITUDINAL SURFACE SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- VACUUM INDUCTION MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
195	1	X
211	6	XXXXXX
227	4	XXXX
243	4	XXXX
259	10	XXXXXXXXXX
275	9	XXXXXXXXX
292	8	XXXXXXXX
308	5	XXXXX
324	1	X

Number of Tests	48
Arithmetic Mean	261.8
Standard Deviation	31.6
Maximum Value	315.8
Minimum Value	186.4
Standard Deviation of the Mean	4.57

Class Mid-Point N/S Ratio	Frequency	
.666	2	XX
.717	5	XXXXX
.768	4	XXXX
.819	8	XXXXXXXX
.871	5	XXXXX
.922	10	XXXXXXXXXX
.973	7	XXXXXXX
1.02	6	XXXXXX
1.08	1	X

Number of Tests	48
Arithmetic Mean	0.88
Standard Deviation	0.104
Maximum Value	1.05
Minimum Value	0.64
Standard Deviation of the Mean	0.0151

FIGURE 5-71

HISTOGRAMS FOR NOTCHED LONGITUDINAL MID-RADIUS SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- VACUUM INDUCTION MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
211	5	XXXXX
222	5	XXXXX
234	7	XXXXXXX
245	4	XXXX
257	5	XXXXX
269	4	XXXX
280	1	X
292	0	
303	1	X

Number of Tests	32
Arithmetic Mean	241.2
Standard Deviation	21.3
Maximum Value	297.5
Minimum Value	204.8
Standard Deviation of the Mean	3.77

Class Mid-Point N/S Ratio	Frequency	
.749	6	XXXXXX
.788	7	XXXXXXX
.827	4	XXXX
.866	6	XXXXXX
.904	7	XXXXXXX
.943	0	
.982	1	X
1.02	0	
1.06	1	X

Number of Tests	32
Arithmetic Mean	0.84
Standard Deviation	0.075
Maximum Value	1.04
Minimum Value	0.73
Standard Deviation of the Mean	0.0133

FIGURE 5-72

HISTOGRAMS FOR NOTCHED LONGITUDINAL CENTER SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- VACUUM INDUCTION MELT-VAR BILLET

Class Mid-Point F_{tu} Ksi	Frequency	
211	5	XXXXX
222	5	XXXXX
234	7	XXXXXXX
245	4	XXXX
257	5	XXXXX
269	4	XXXX
280	1	X
292	0	
303	1	X

Number of Tests	32
Arithmetic Mean	241.2
Standard Deviation	21.3
Maximum Value	297.5
Minimum Value	204.8
Standard Deviation of the Mean	3.77

Class Mid-Point N/S Ratio	Frequency	
.749	6	XXXXXX
.788	7	XXXXXXX
.827	4	XXXX
.866	6	XXXXXX
.904	7	XXXXXXX
.943	0	
.982	1	X
1.02	0	
1.06	1	X

Number of Tests	32
Arithmetic Mean	0.84
Standard Deviation	0.075
Maximum Value	1.04
Minimum Value	0.73
Standard Deviation of the Mean	0.0133

FIGURE 5-72

HISTOGRAMS FOR NOTCHED LONGITUDINAL CENTER SPECIMEN ULTIMATE STRENGTH AND NOTCH/SMOOTH STRENGTH RATIO -- VACUUM INDUCTION MELT-VAR BILLET

APPENDIX VI

ARITHMETIC MEAN AND RANGE CONTROL CHARTS FOR TENSILE PROPERTIES DETERMINED FOR EACH MELT PROCESS VARIATION

SECTION 1

ARITHMETIC MEAN AND RANGE CONTROL CHARTS FOR TENSILE PROPERTIES OF AIR MELT-VAR HEAT W-24341-1

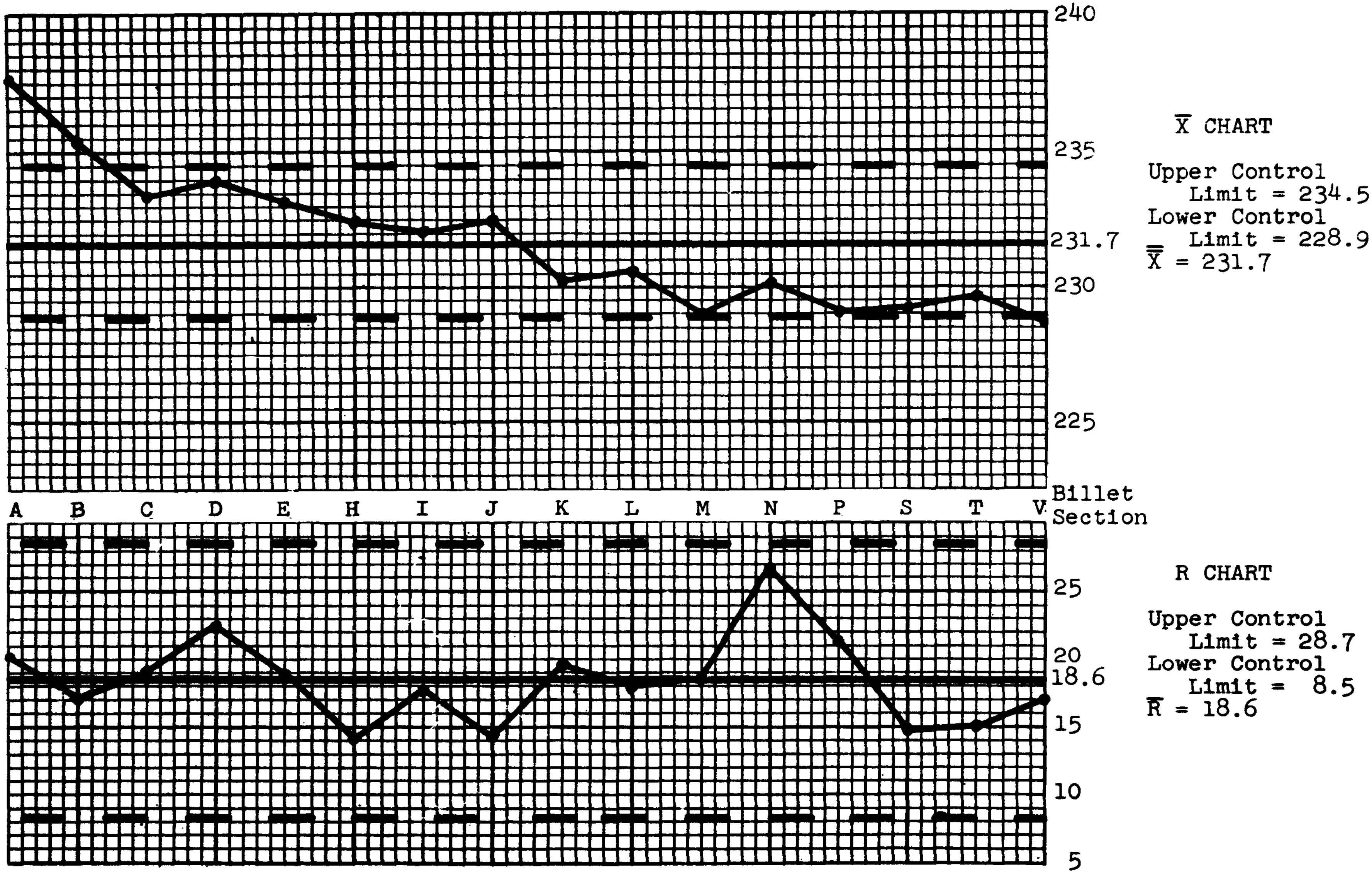


FIGURE 6-1

CONTROL CHART FOR YIELD STRENGTH OF SMOOTH TRANSVERSE TENSILE SPECIMENS FROM AIR MELT-VAR BILLET

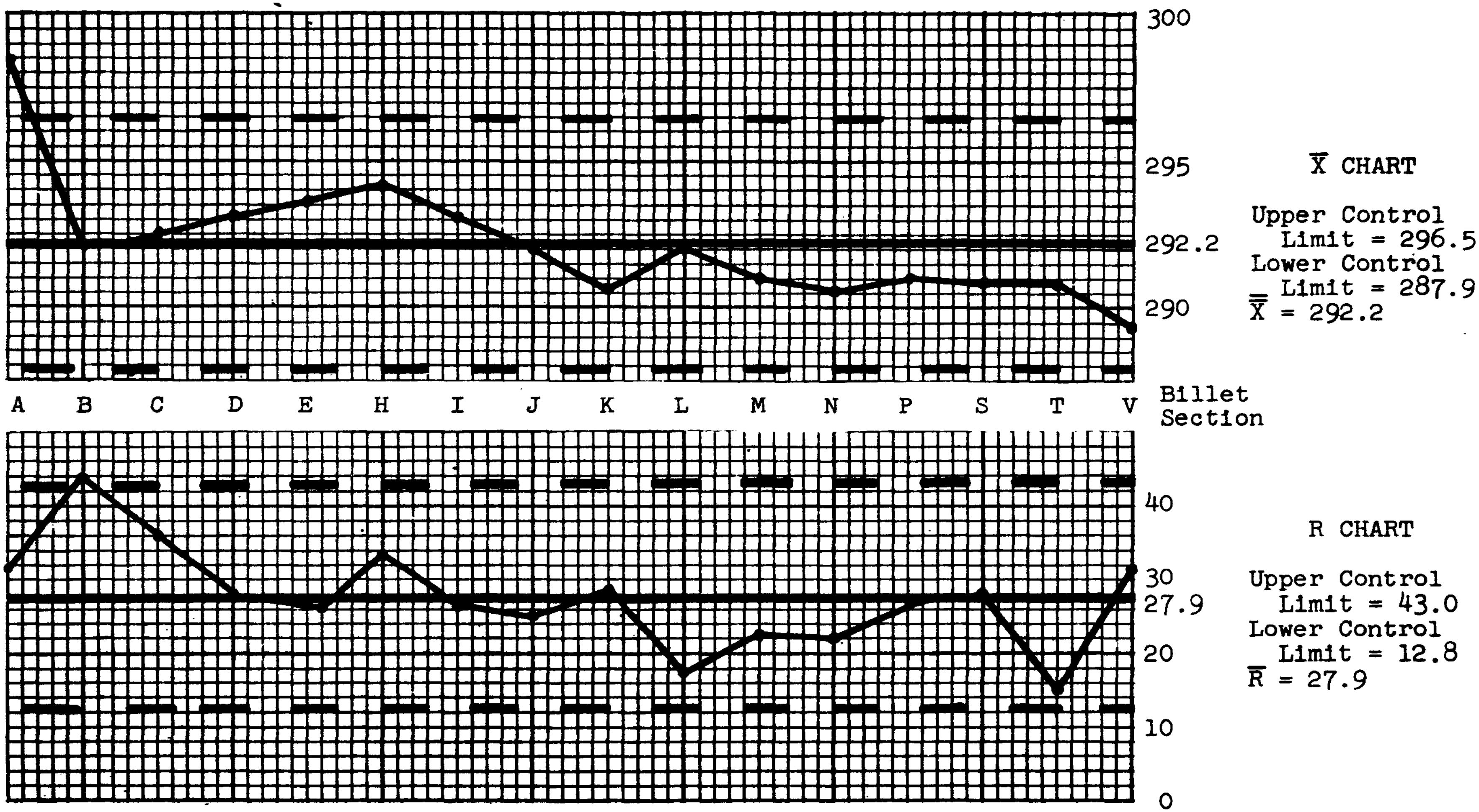


FIGURE 6-2

CONTROL CHART FOR ULTIMATE STRENGTH OF SMOOTH TRANSVERSE TENSILE SPECIMENS FROM AIR MELT-VAR BILLET

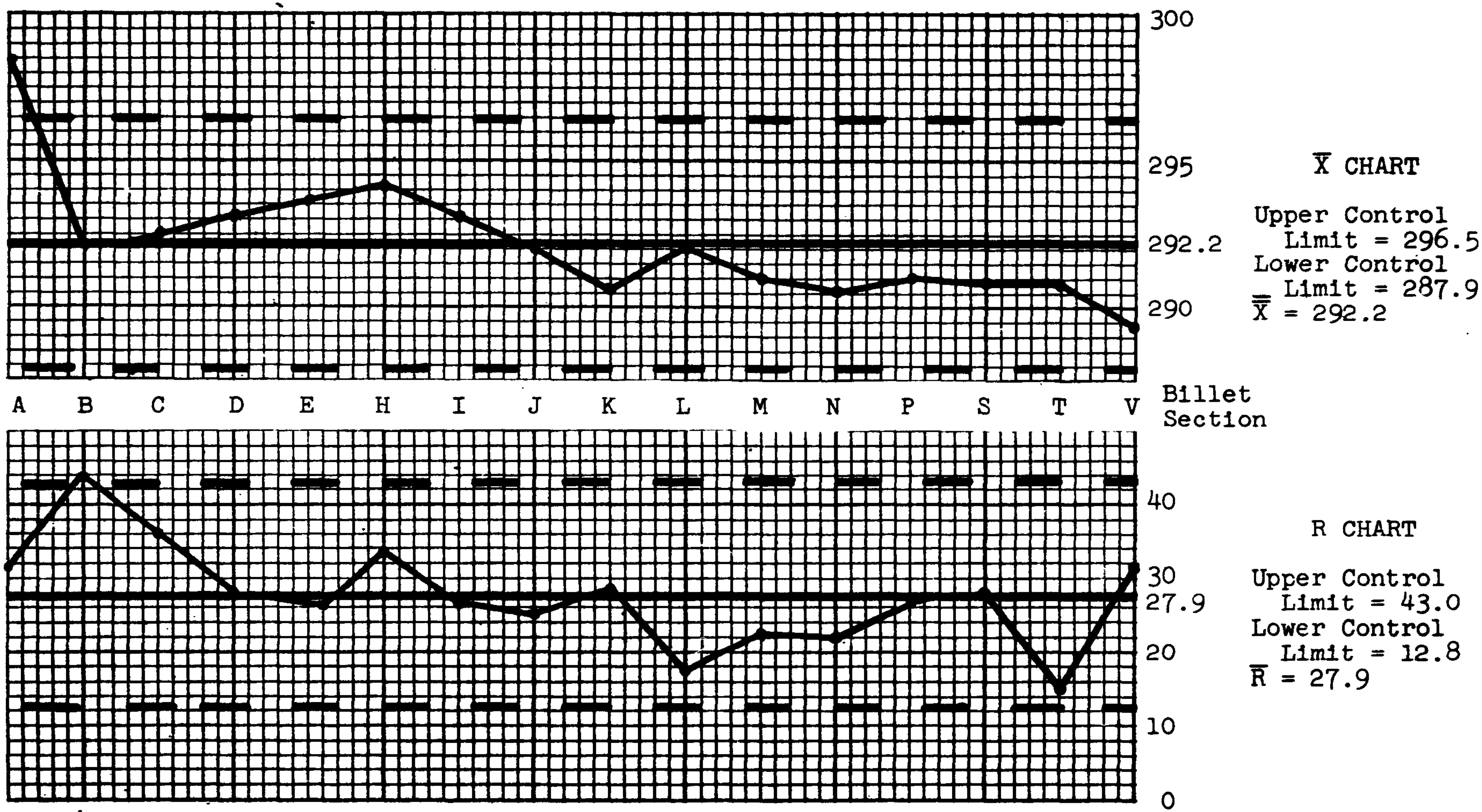


FIGURE 6-2

CONTROL CHART FOR ULTIMATE STRENGTH OF SMOOTH TRANSVERSE TENSILE SPECIMENS FROM AIR MELT-VAR BILLET

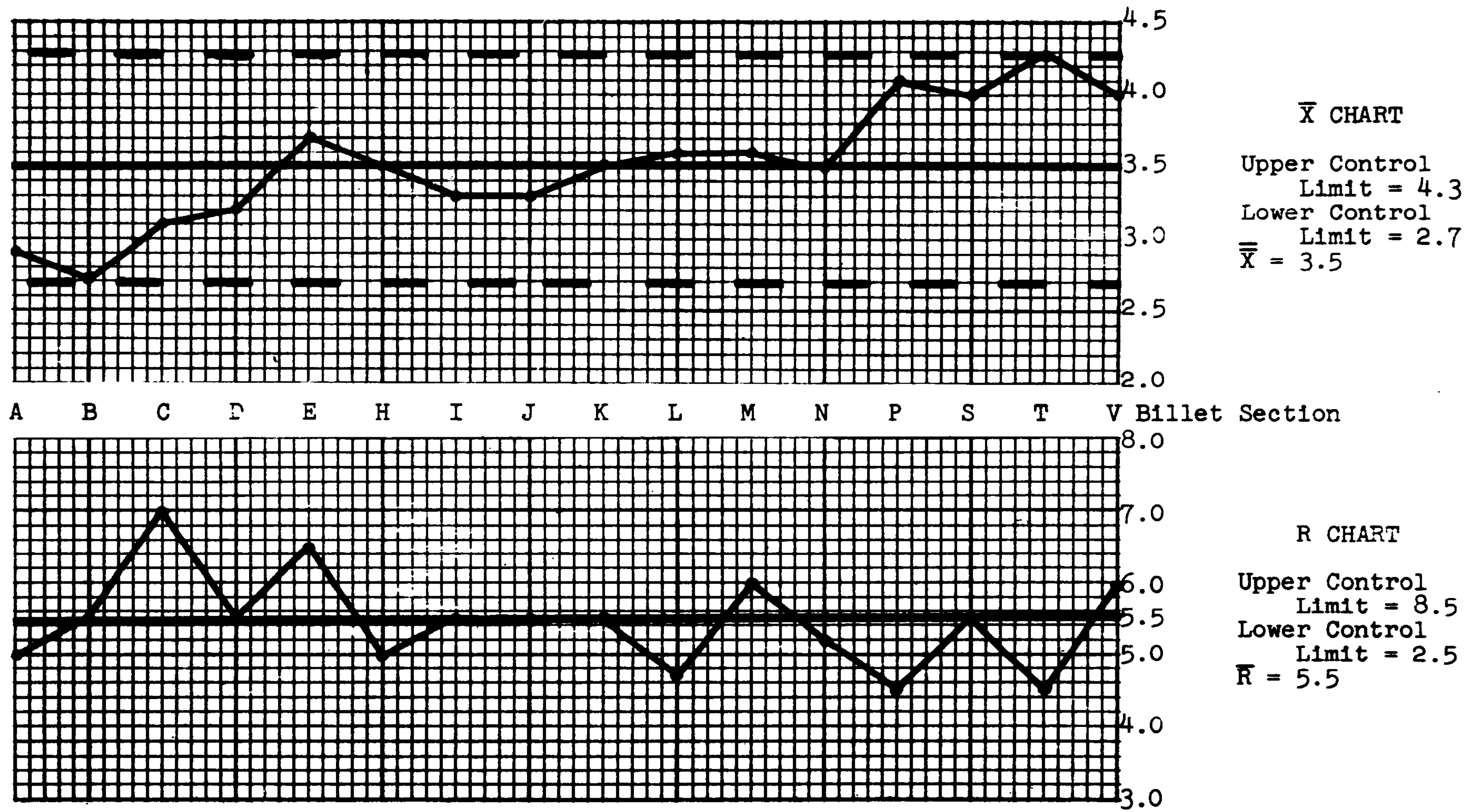


FIGURE 6-3

CONTROL CHART FOR PER CENT ELONGATION OF SMOOTH TRANSVERSE TENSILE SPECIMENS FROM AIR MELT-VAR BILLET

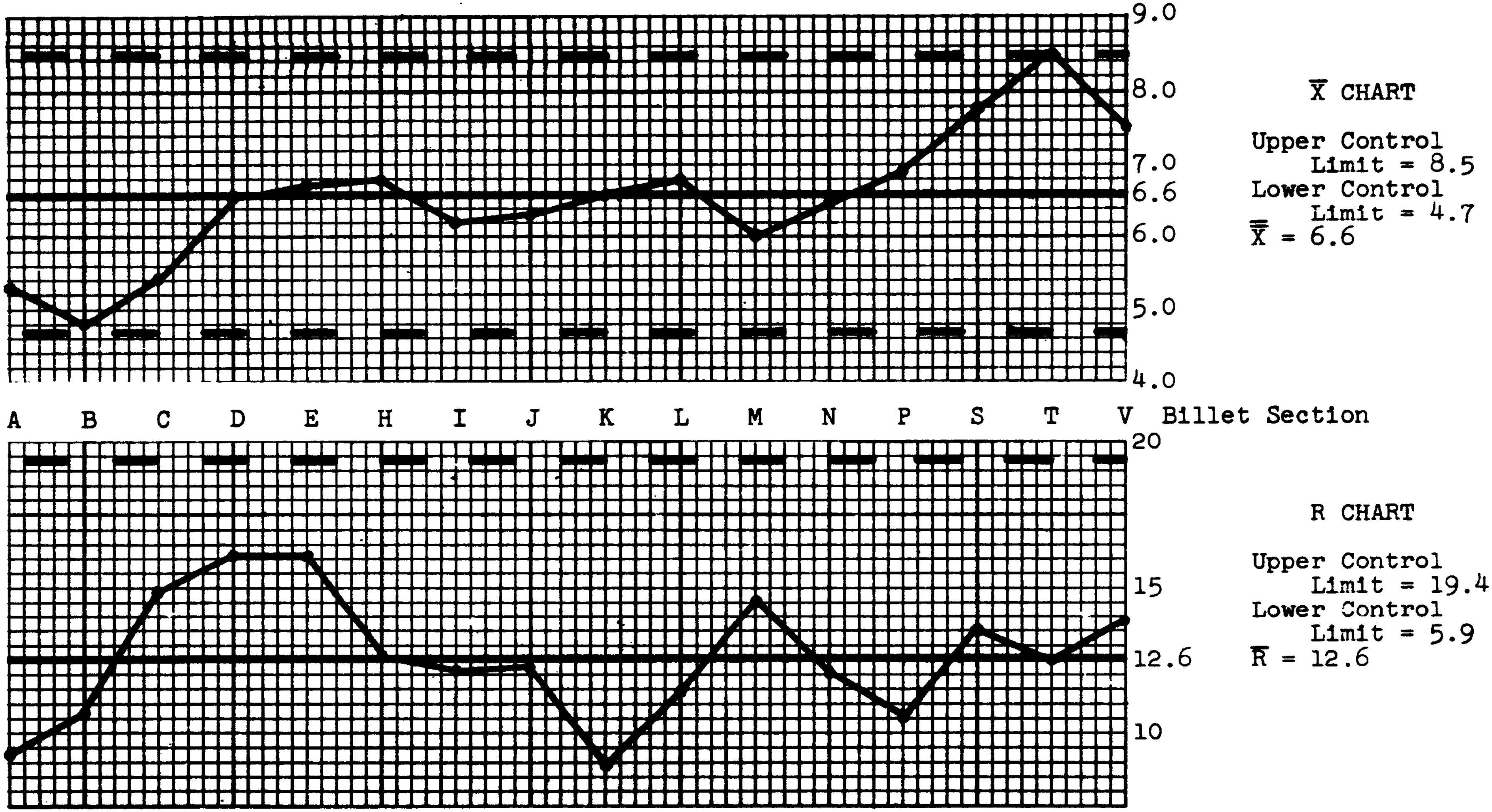


FIGURE 6-4

CONTROL CHART FOR PER CENT REDUCTION IN AREA OF SMOOTH TRANSVERSE TENSILE SPECIMENS FROM AIR MELT-VAR BILLET

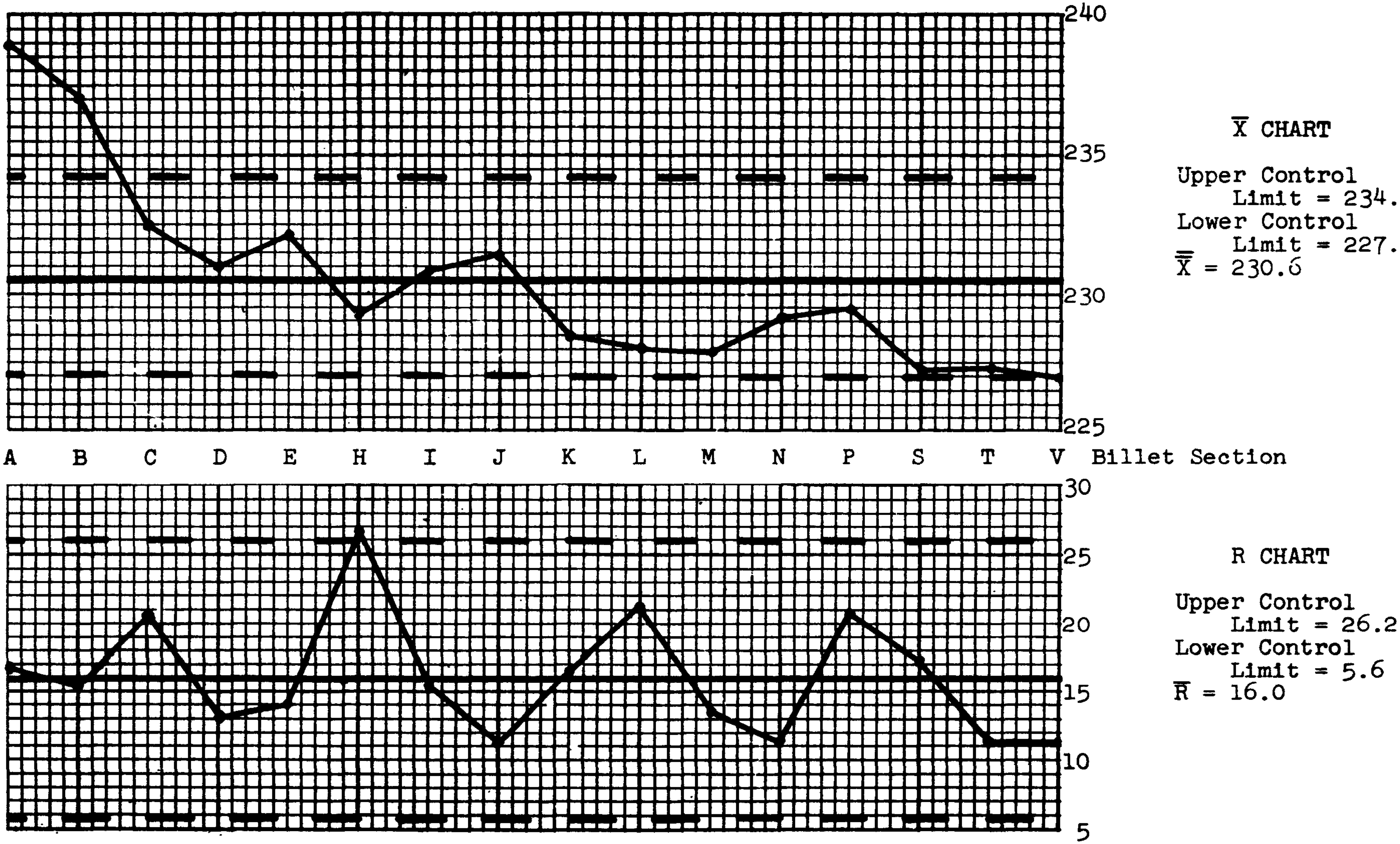


FIGURE 6-5

CONTROL CHART FOR YIELD STRENGTH OF SMOOTH LONGITUDINAL TENSILE SPECIMENS FROM AIR MELT-VAR BILLET

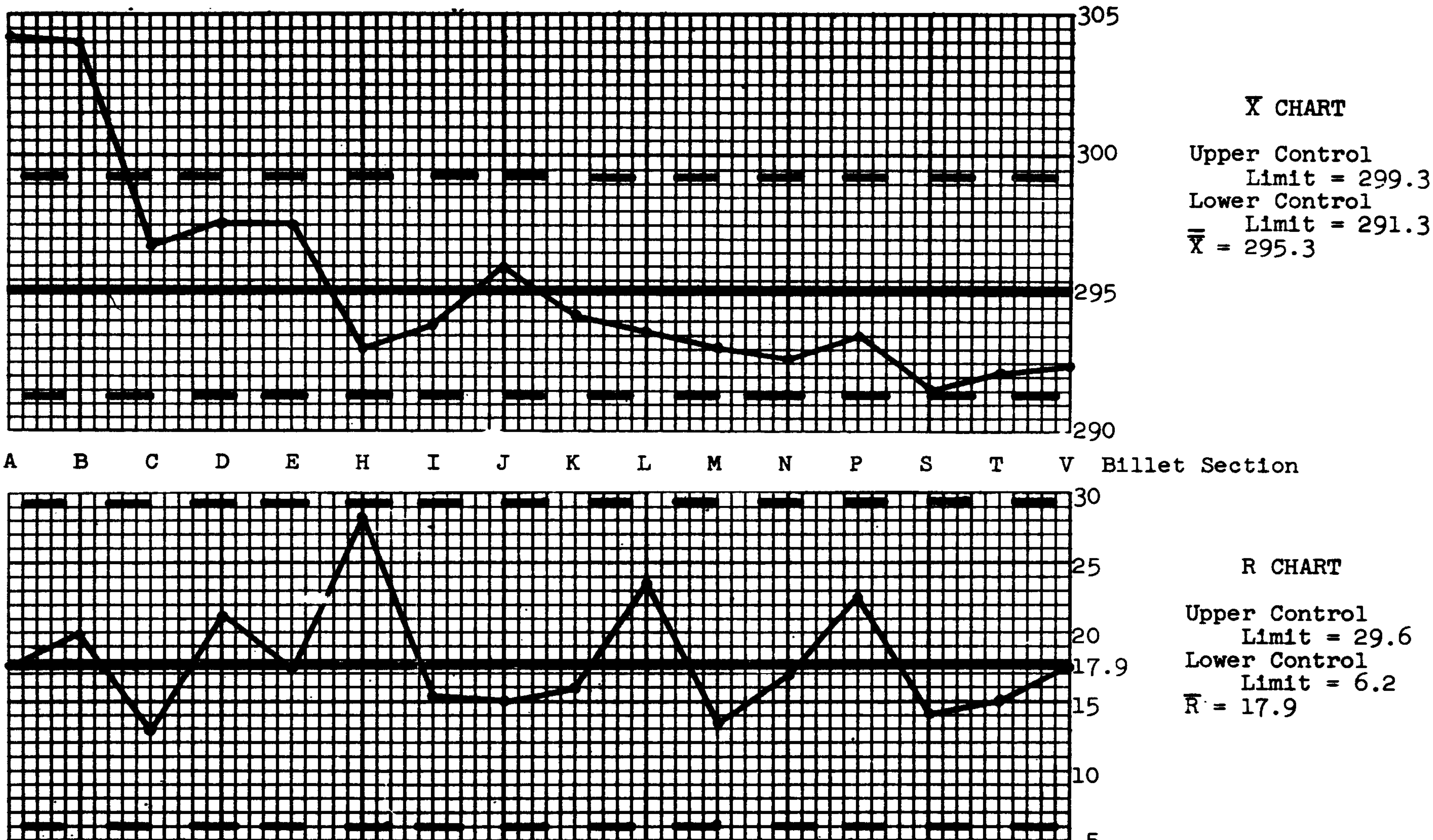


FIGURE 6-6

CONTROL CHART FOR ULTIMATE STRENGTH OF SMOOTH LONGITUDINAL TENSILE SPECIMENS FROM AIR MELT-VAR BILLET

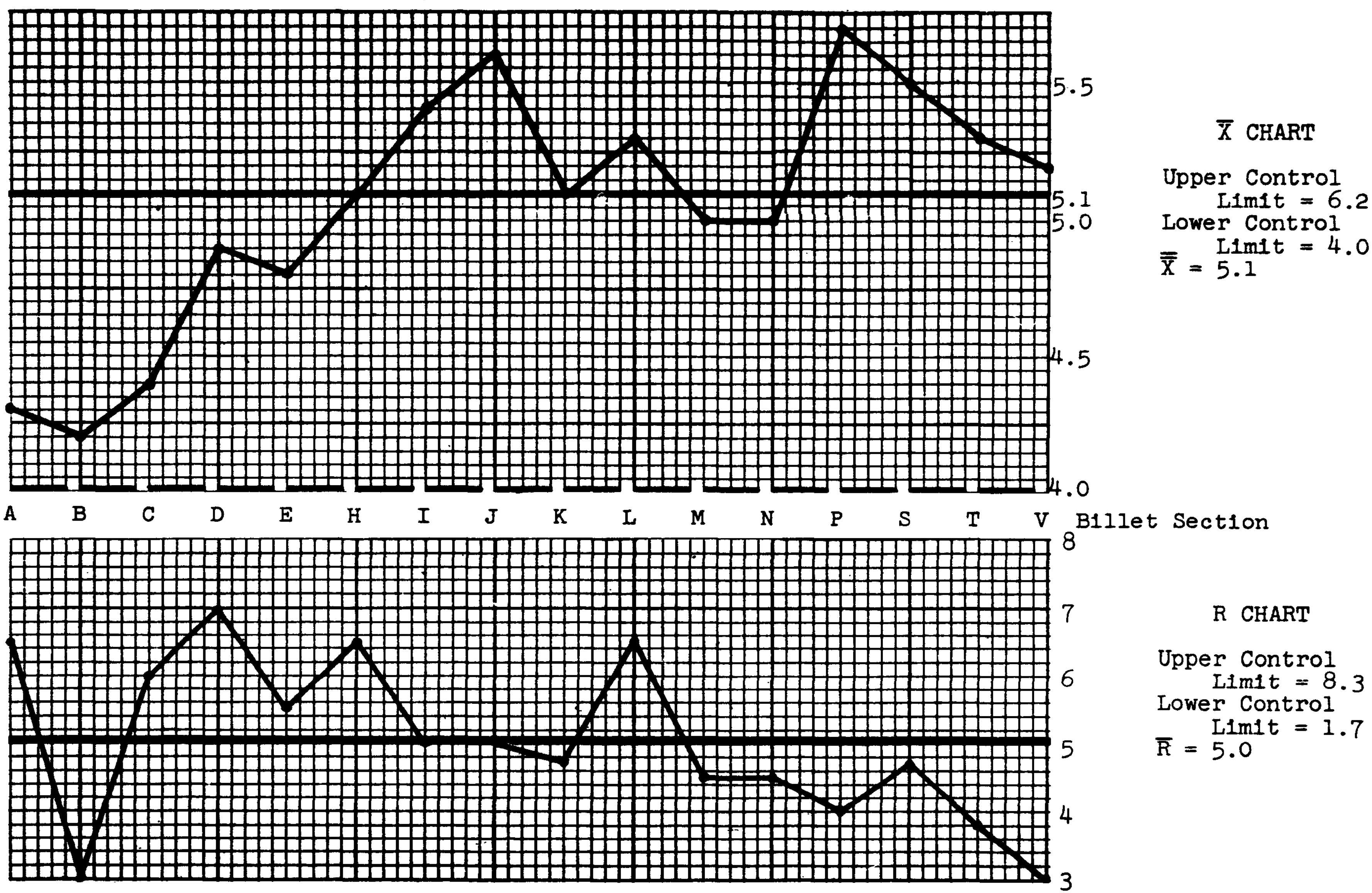


FIGURE 6-7

CONTROL CHART FOR PER CENT ELONGATION OF SMOOTH LONGITUDINAL TENSILE SPECIMENS FROM AIR MELT-VAR BILLET

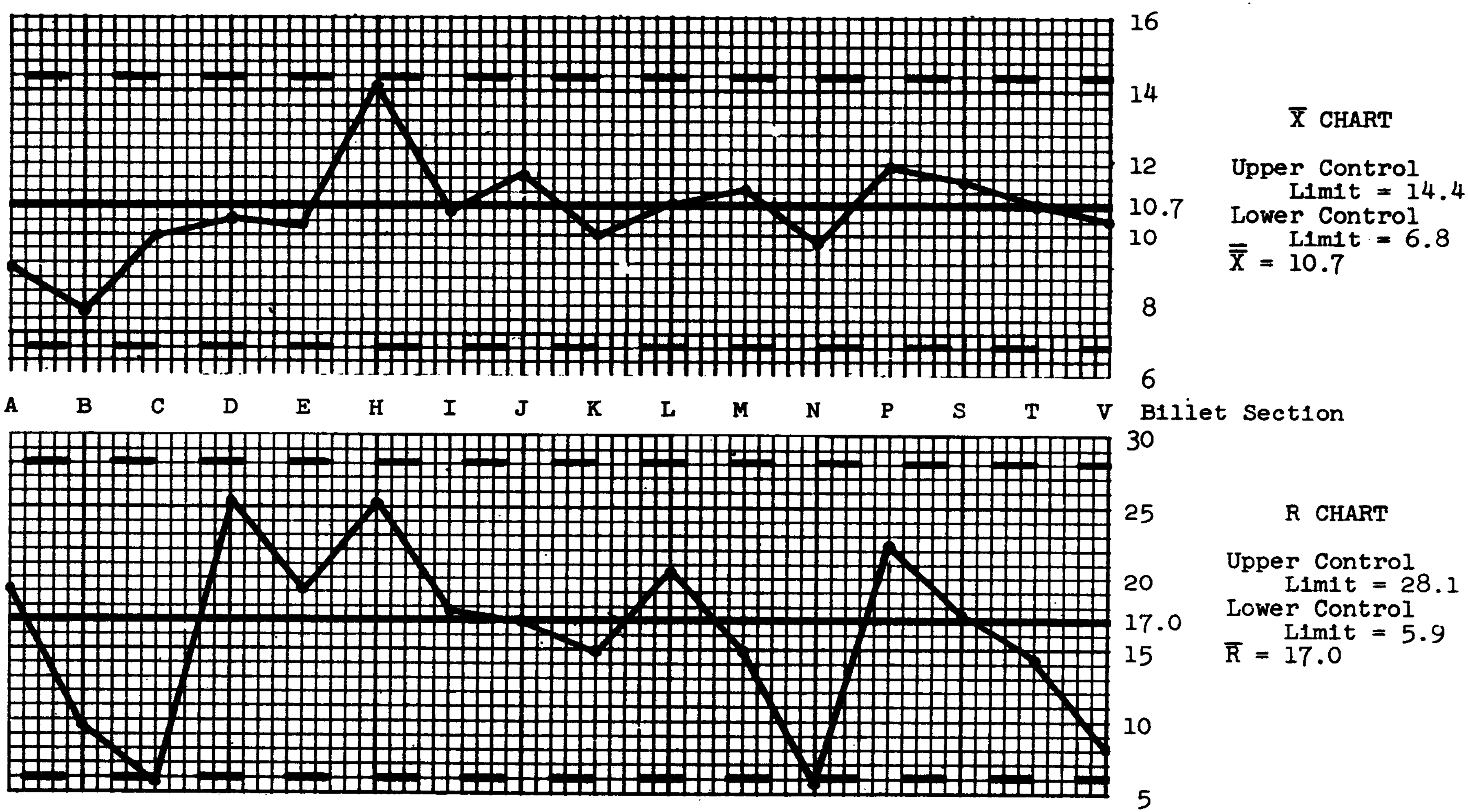


FIGURE 6-8

CONTROL CHART FOR PER CENT REDUCTION IN AREA OF SMOOTH LONGITUDINAL TENSILE SPECIMENS FROM AIR MELT-VAR BILLET

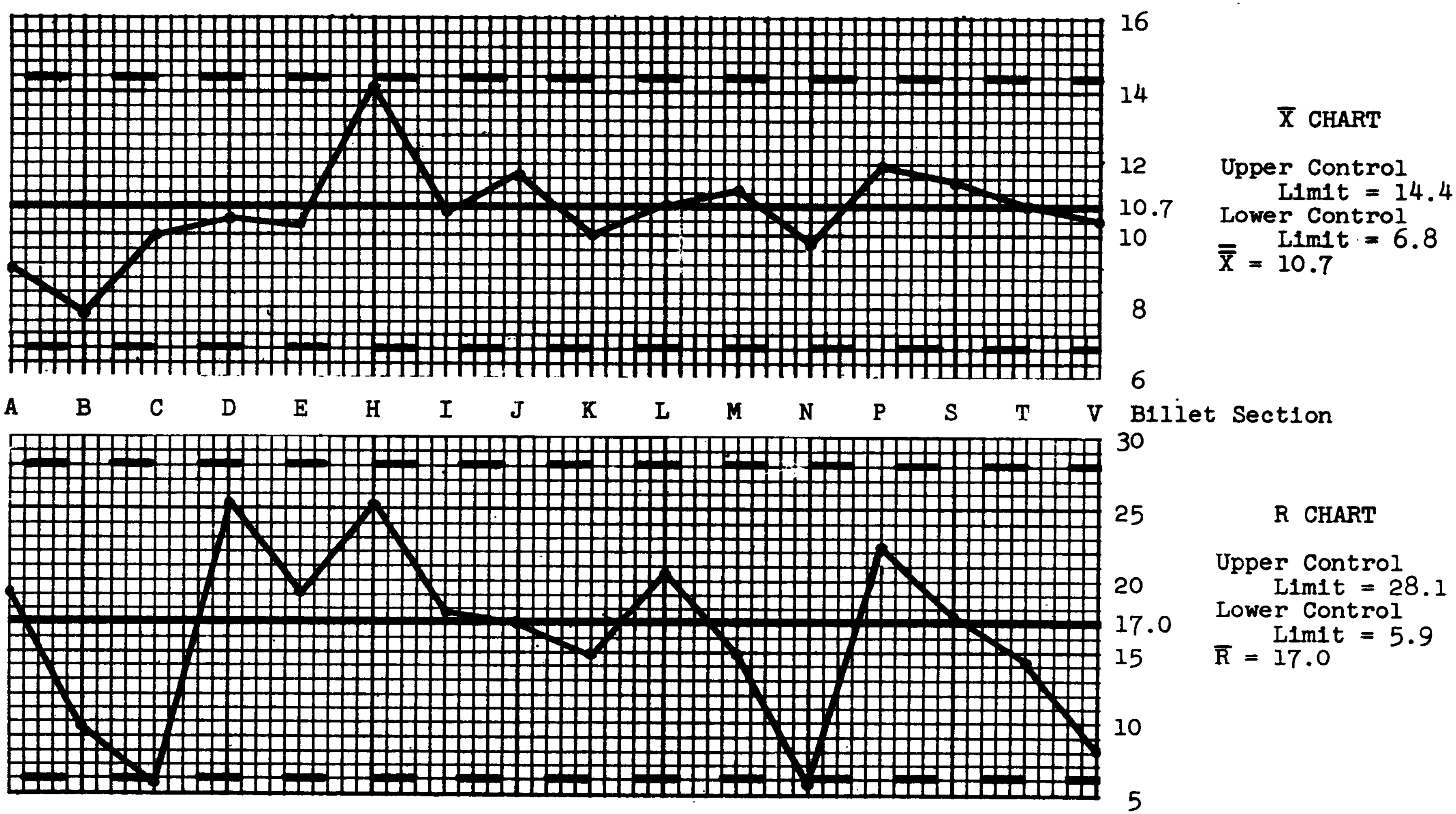


FIGURE 6-8

CONTROL CHART FOR PER CENT REDUCTION IN AREA OF SMOOTH LONGITUDINAL TENSILE SPECIMENS FROM AIR MELT-VAR BILLET

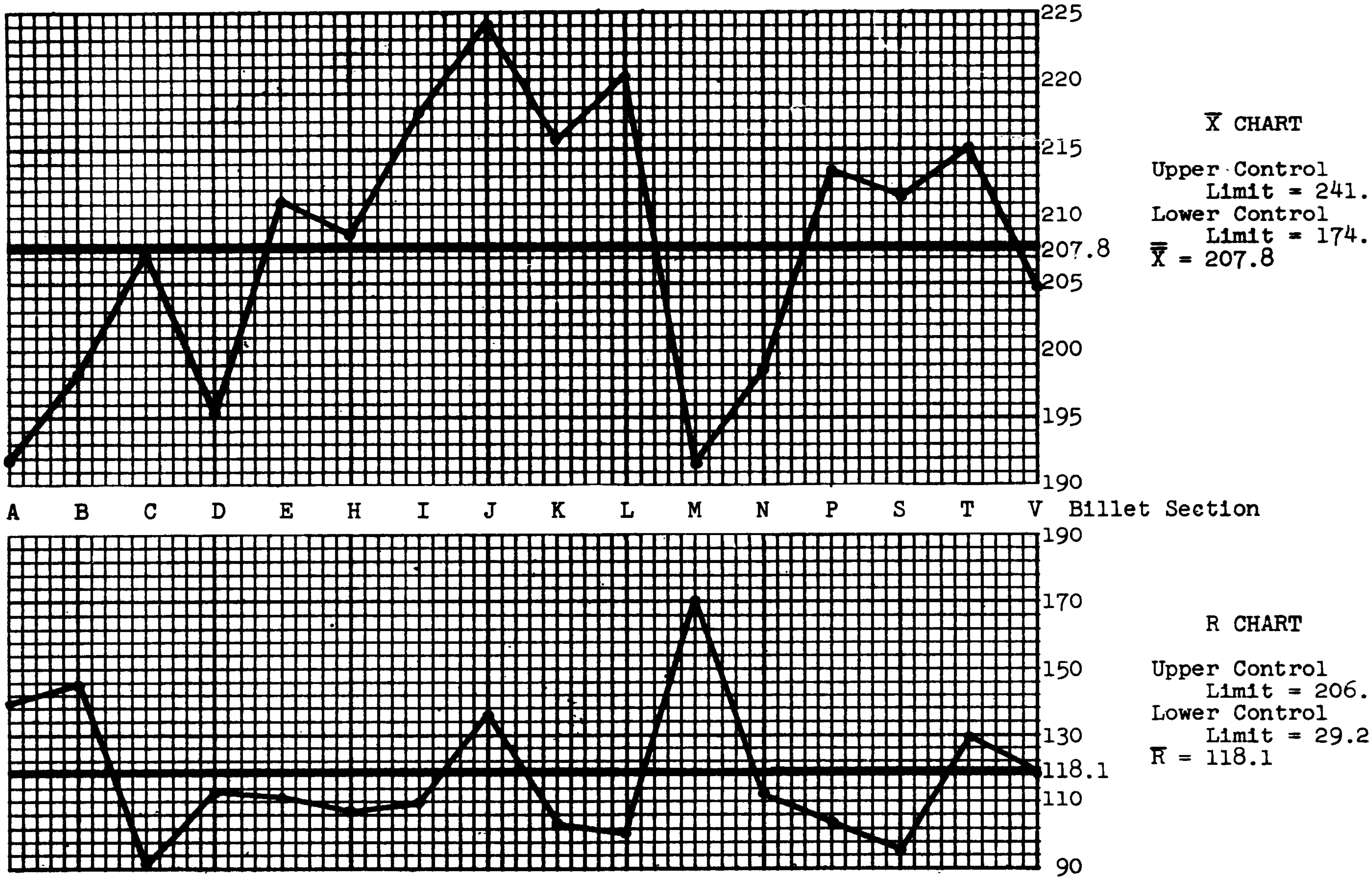


FIGURE 6-9

CONTROL CHART FOR ULTIMATE STRENGTH OF NOTCHED TRANSVERSE TENSILE SPECIMENS FROM AIR MELT-VAR BILLET

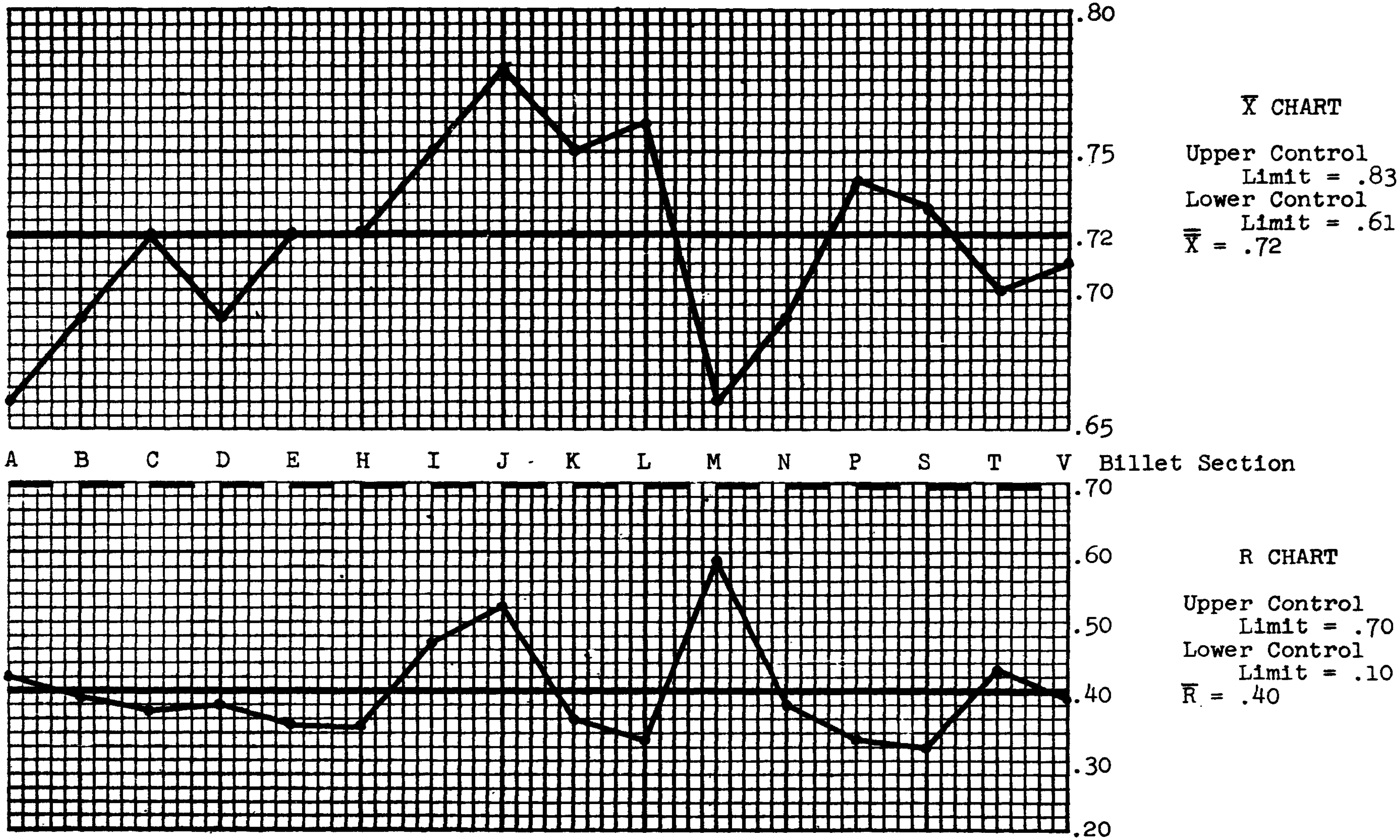


FIGURE 6-10

CONTROL CHART FOR N/S STRENGTH RATIO OF TRANSVERSE TENSILE SPECIMENS FROM AIR MELT-VAR BILLET

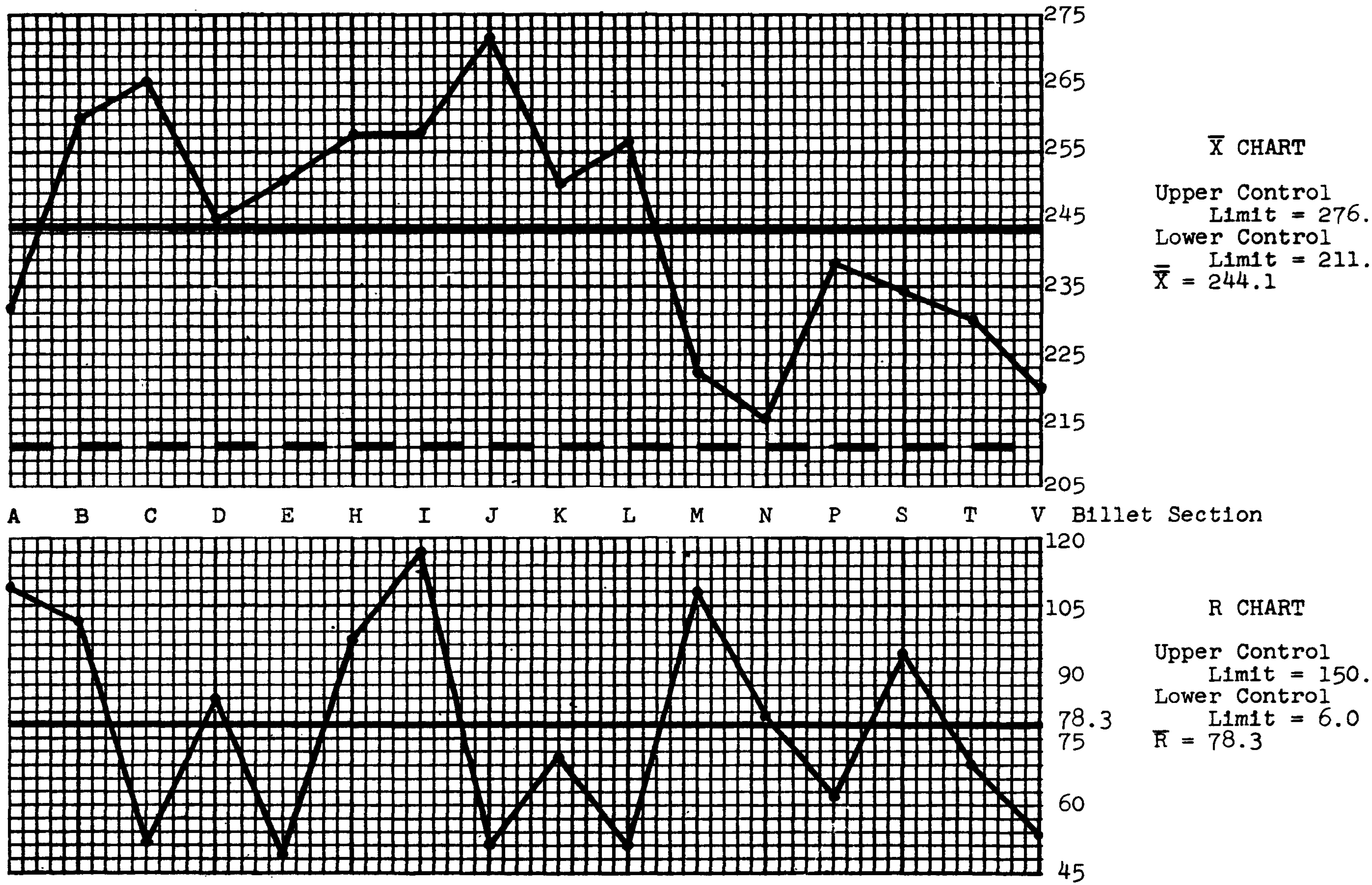


FIGURE 6-11

CONTROL CHART FOR ULTIMATE STRENGTH OF NOTCHED LONGITUDINAL TENSILE SPECIMENS FROM AIR MELT-VAR BILLET

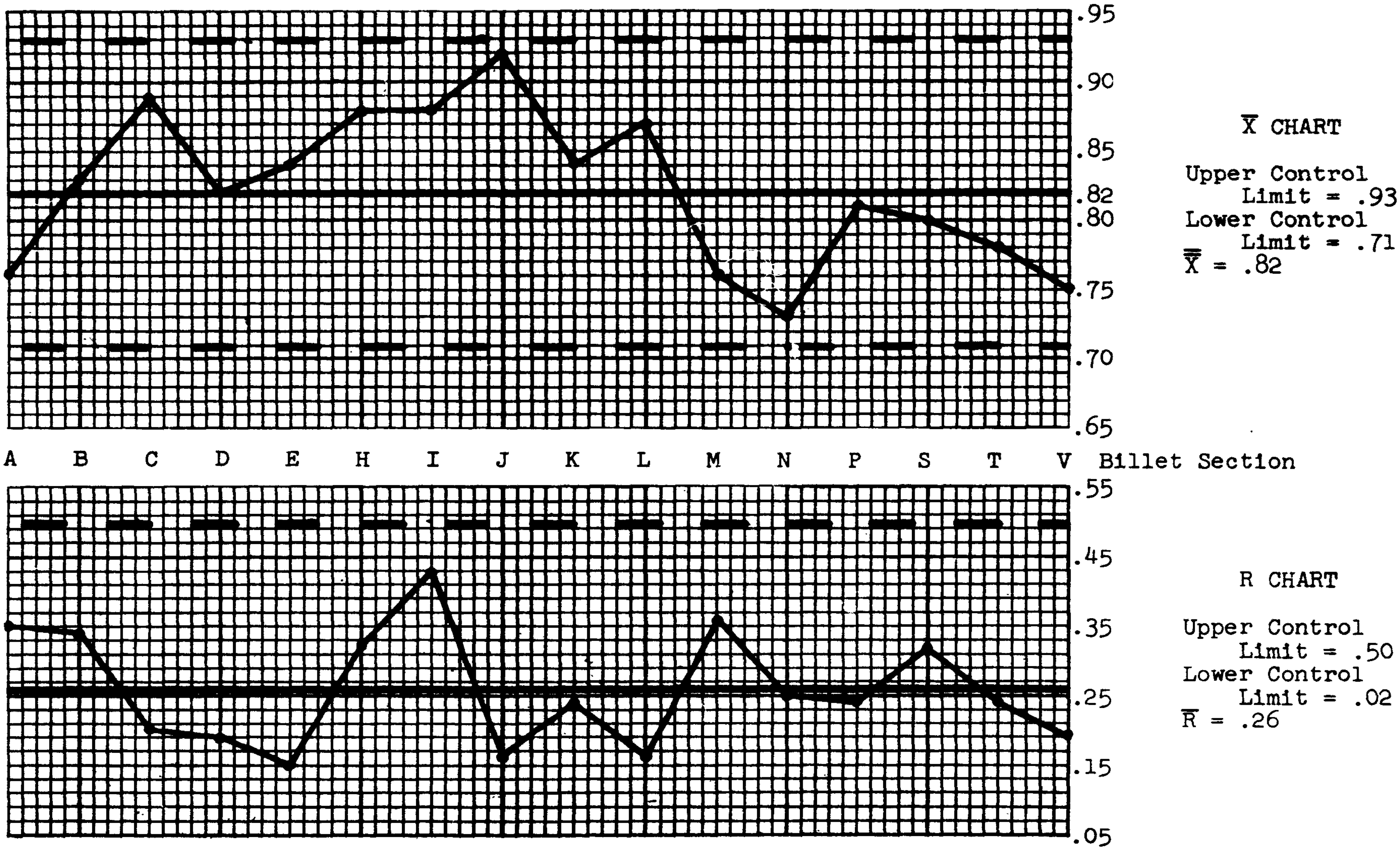


FIGURE 6-12

CONTROL CHART FOR N/S STRENGTH RATIO OF LONGITUDINAL TENSILE SPECIMENS FROM AIR MELT-VAR BILLET

SECTION 2

ARITHMETIC MEAN AND RANGE CONTROL CHARTS FOR TENSILE PROPERTIES OF AIR MELT-DEGAS-VAR HEAT W-24342-V1

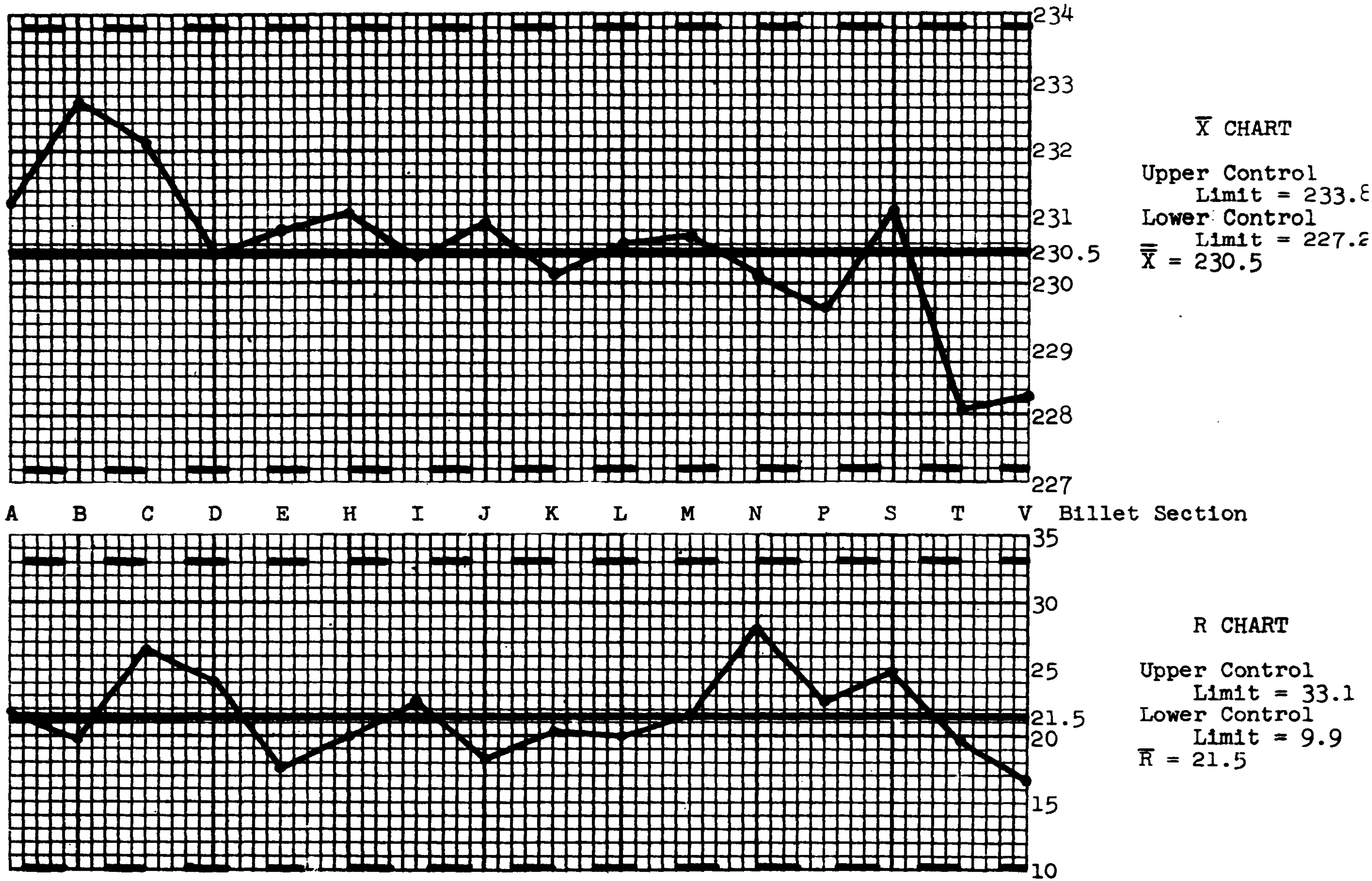


FIGURE 6-13

CONTROL CHART FOR YIELD STRENGTH OF SMOOTH TRANSVERSE TENSILE SPECIMENS FROM AIR MELT-DEGAS-VAR BILLET

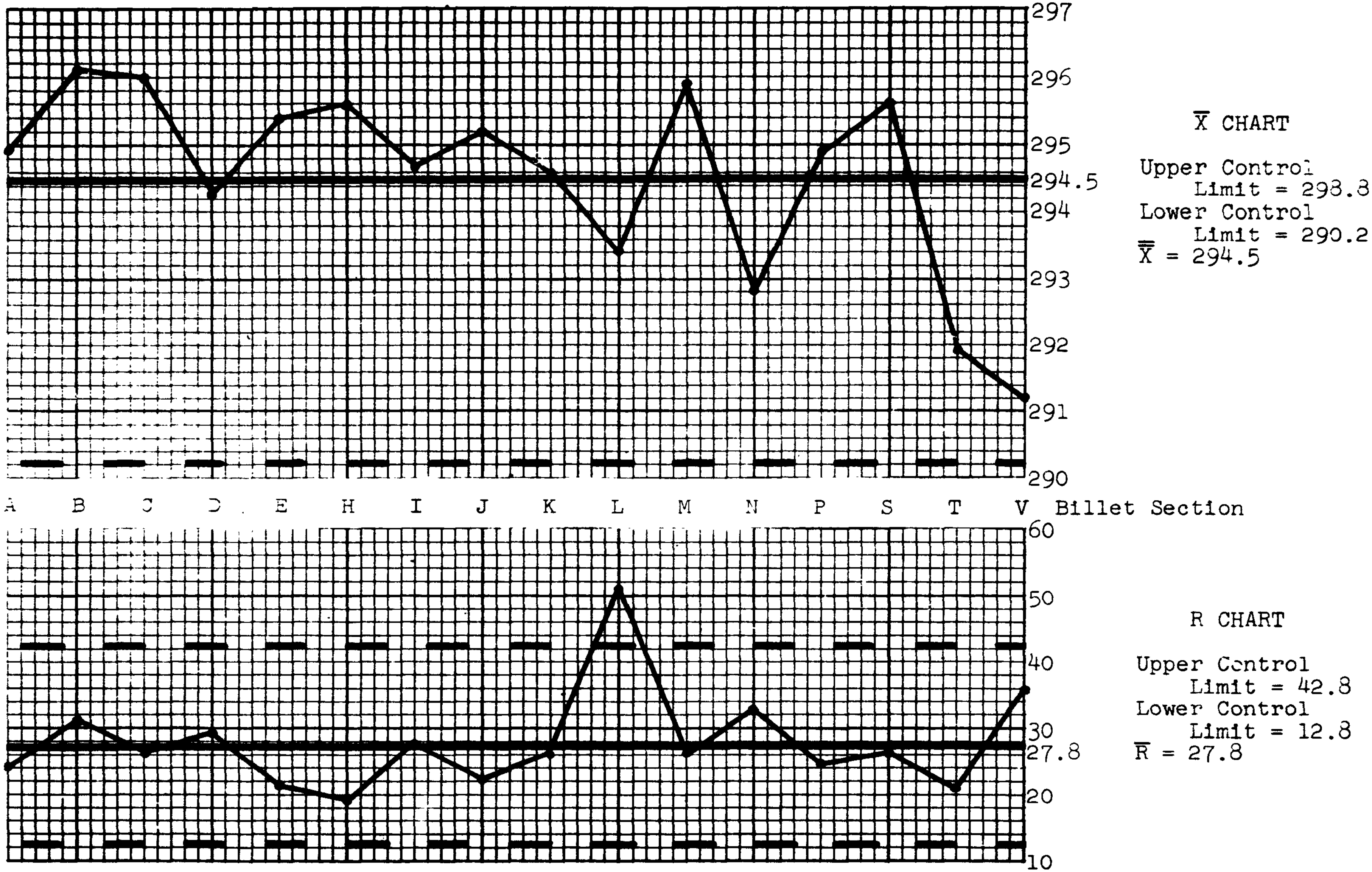


FIGURE 6-14

CONTROL CHART FOR ULTIMATE STRENGTH OF SMOOTH TRANSVERSE TENSILE SPECIMENS FROM AIR MELT-DEGAS-VAR BILLET

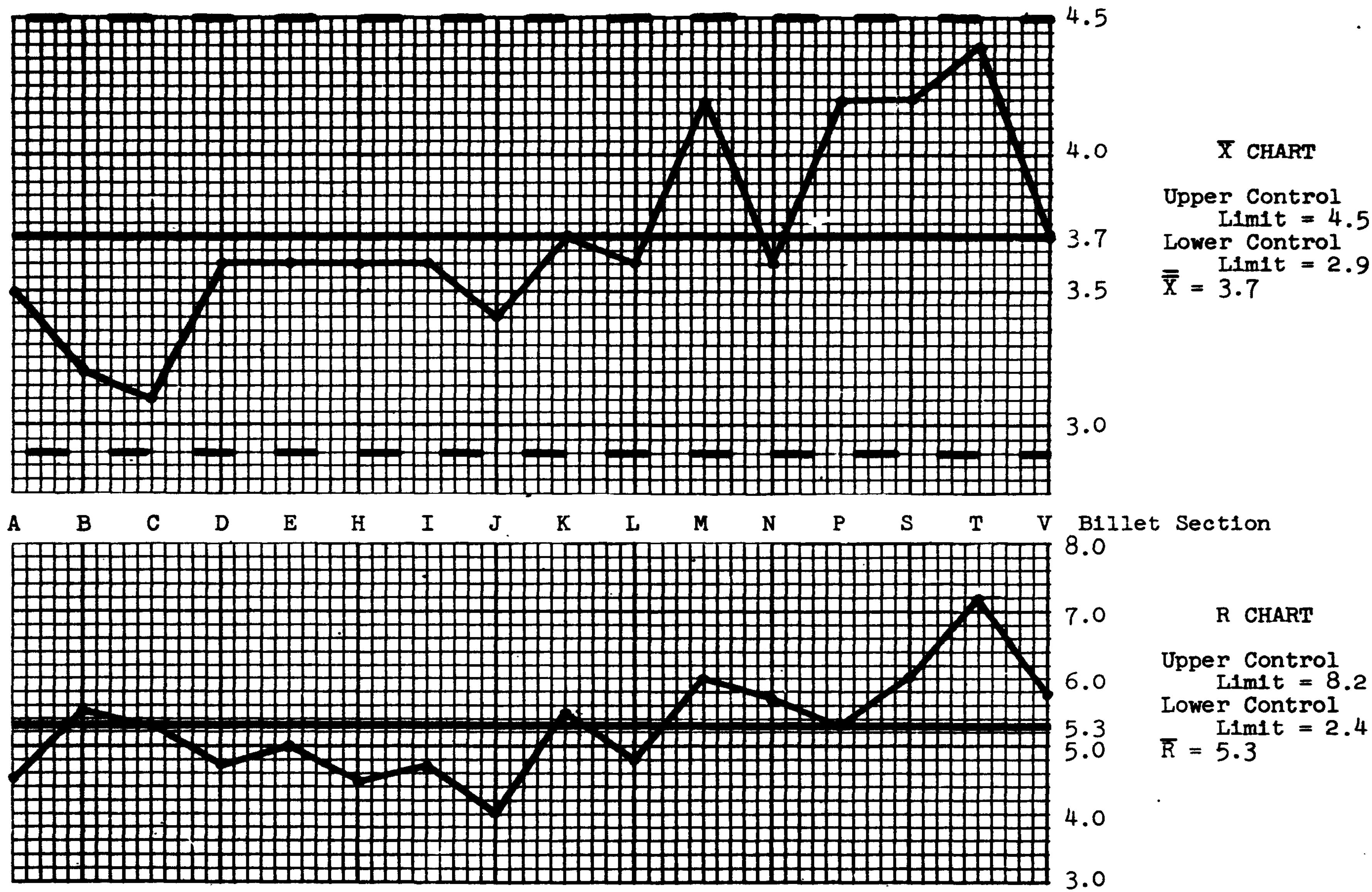


FIGURE 6-15

CONTROL CHART FOR PER CENT ELONGATION OF SMOOTH TRANSVERSE TENSILE SPECIMENS FROM AIR MELT-DEGAS-VAR BILLET

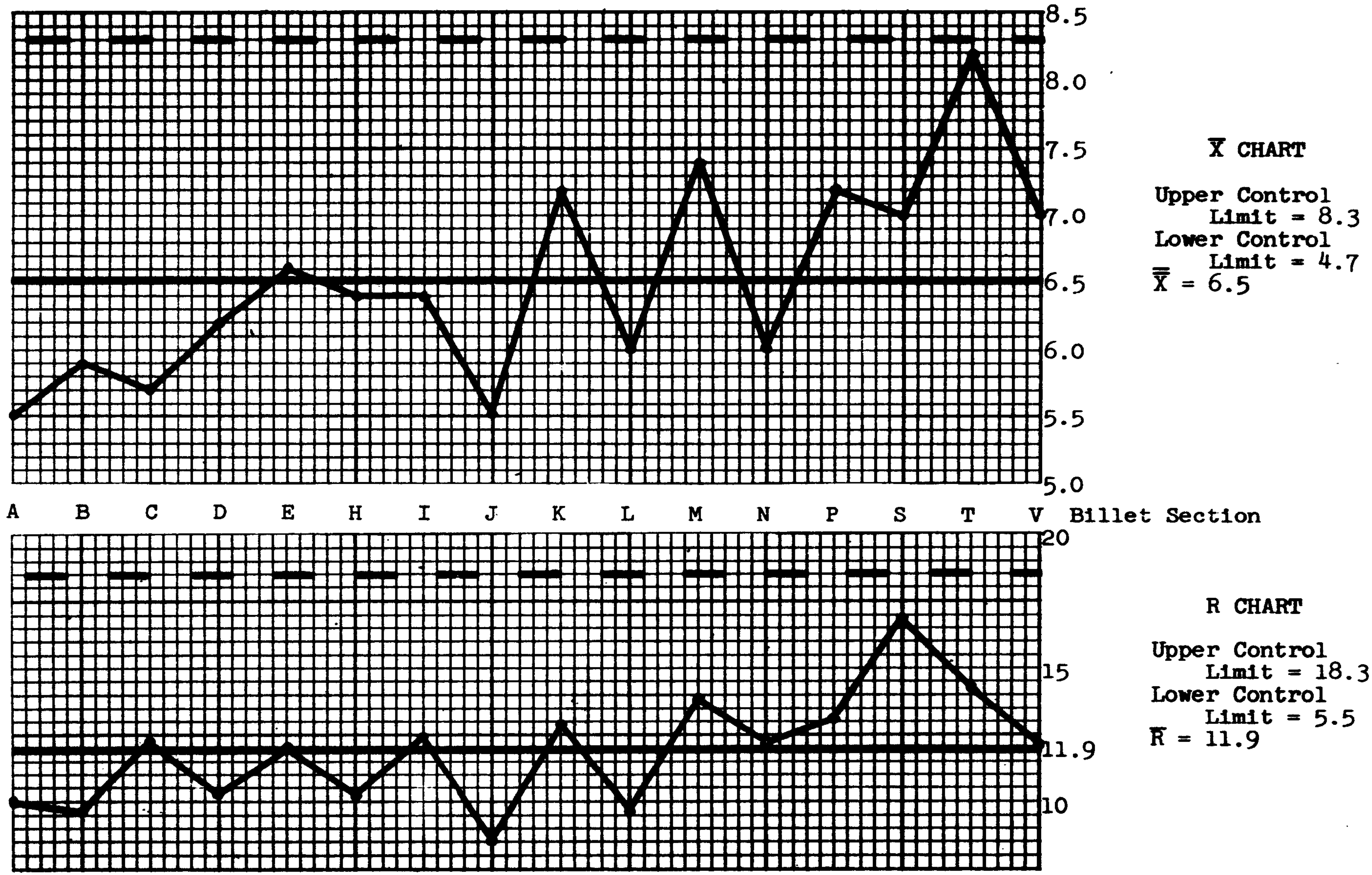


FIGURE 6-16

CONTROL CHART FOR PER CENT REDUCTION IN AREA OF SMOOTH TRANSVERSE TENSILE SPECIMENS FROM AIR MELT-DEGAS-VAR BILLET

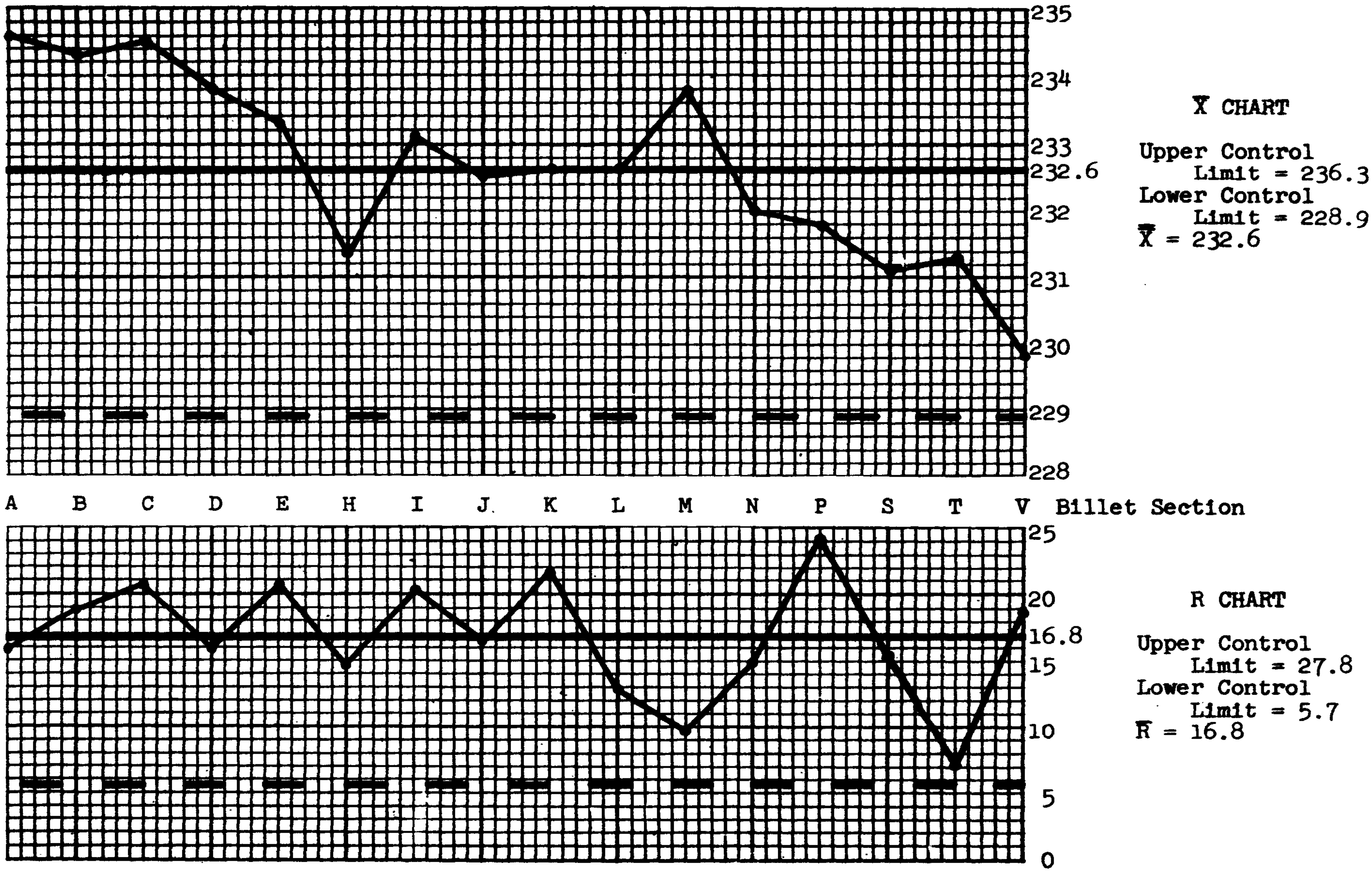


FIGURE 6-17

CONTROL CHART FOR YIELD STRENGTH OF SMOOTH LONGITUDINAL TENSILE SPECIMENS FROM AIR MELT-DEGAS-VAR BILLET

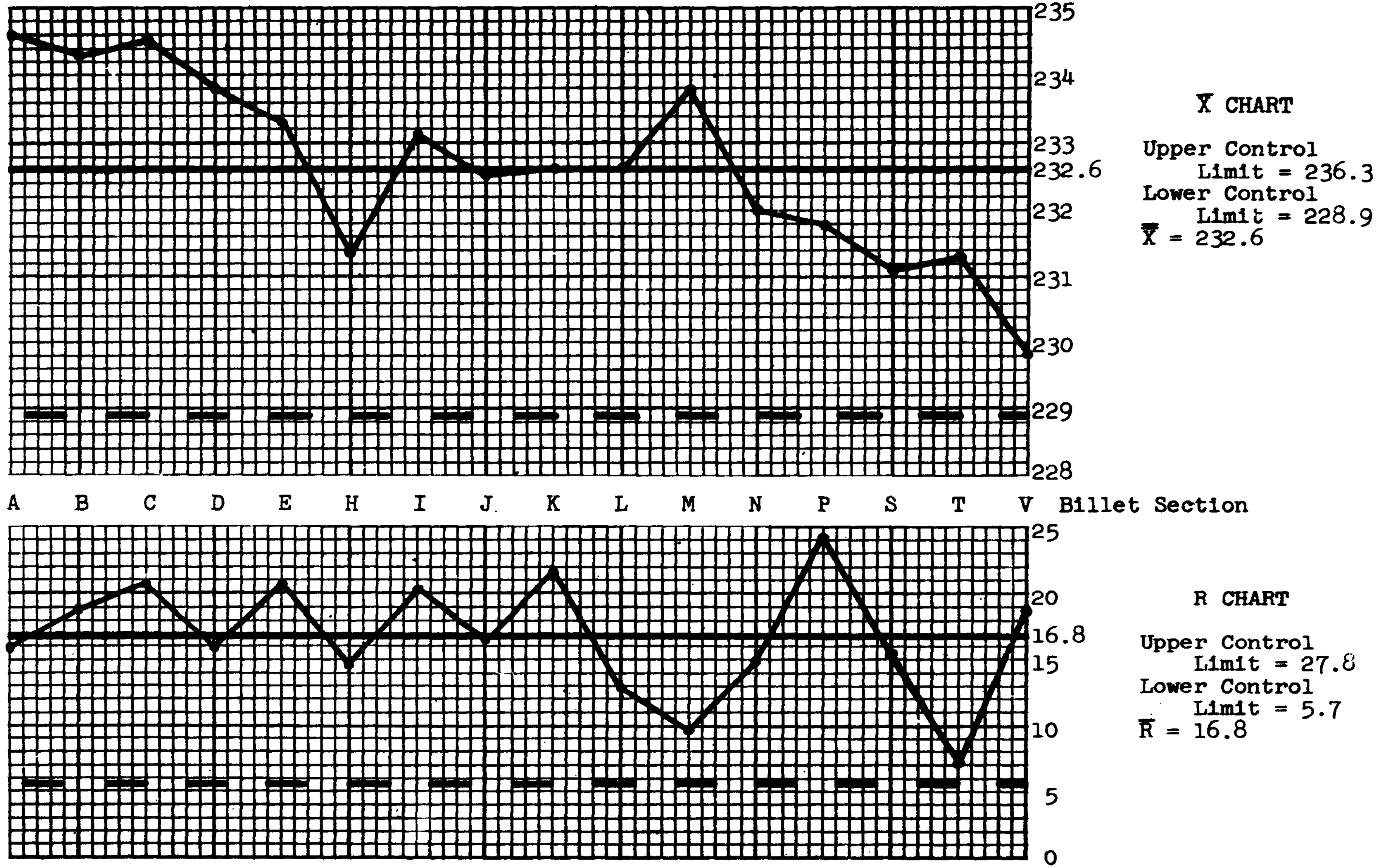


FIGURE 6-17

CONTROL CHART FOR YIELD STRENGTH OF SMOOTH LONGITUDINAL TENSILE SPECIMENS FROM AIR MELT-DEGAS-VAR BILLET

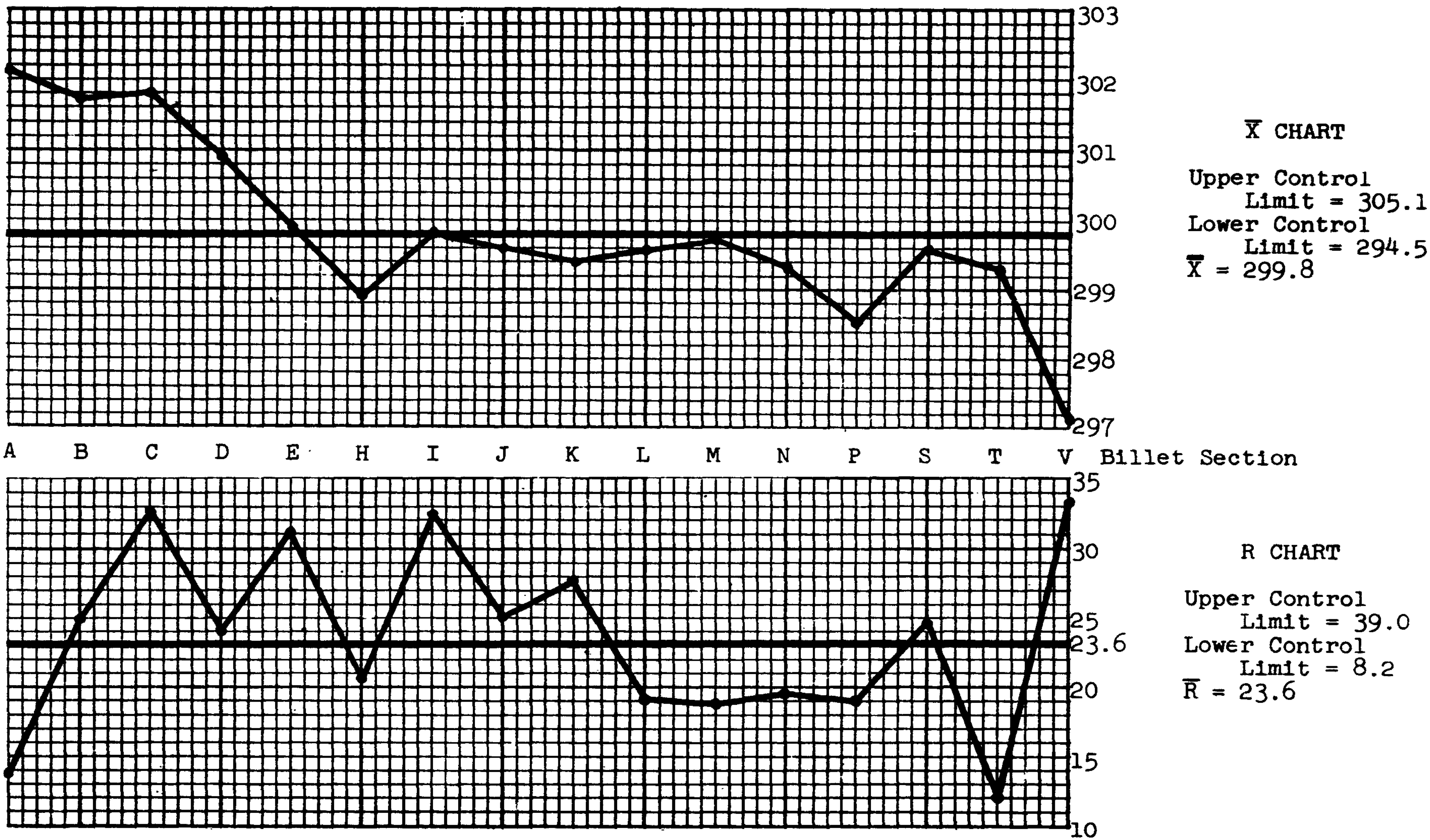


FIGURE 6-18

CONTROL CHART FOR ULTIMATE STRENGTH OF SMOOTH LONGITUDINAL TENSILE SPECIMENS FROM AIR MELT-DEGAS-VAR BILLET

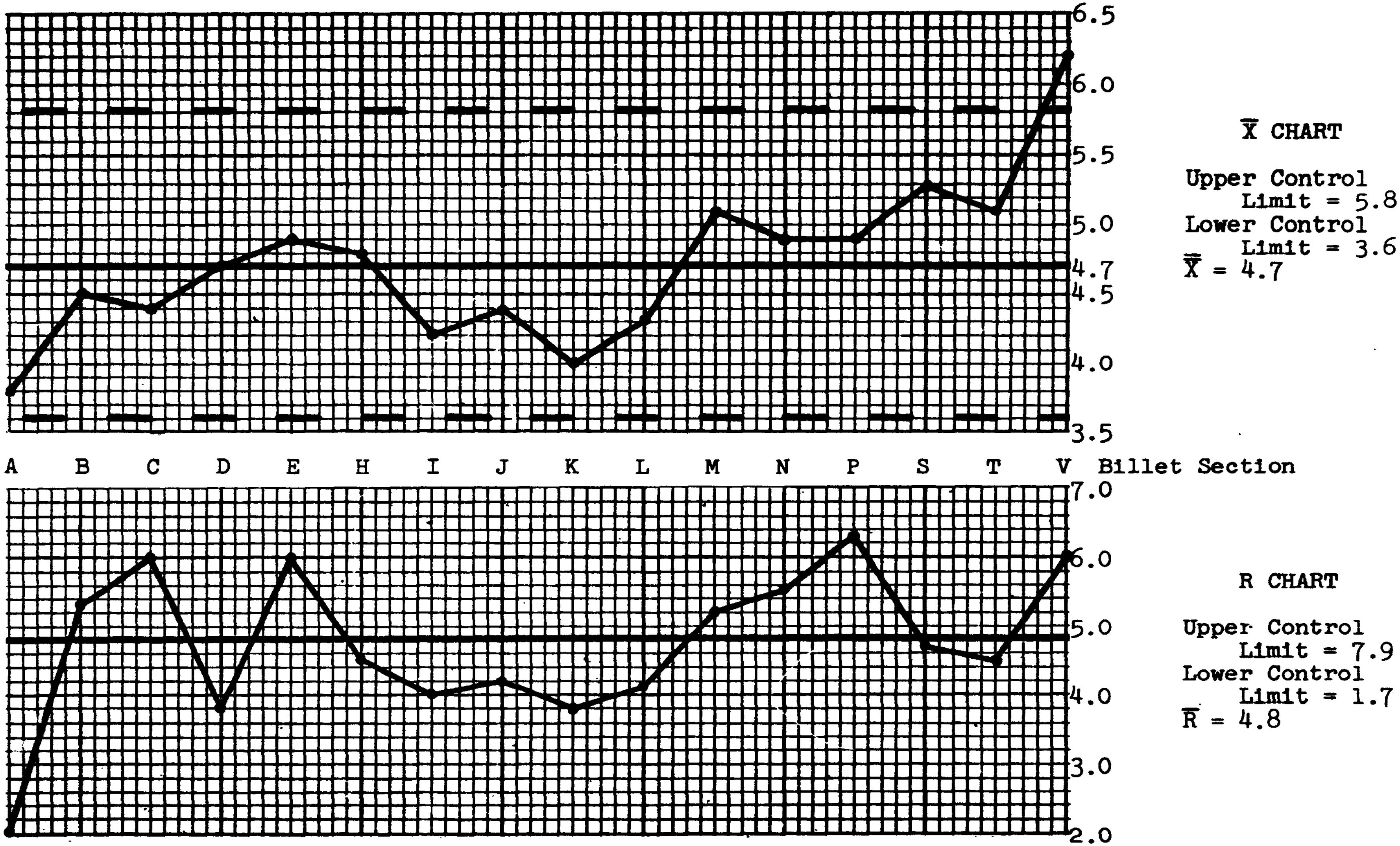


FIGURE 6-19

CONTROL CHART FOR PER CENT ELONGATION OF SMOOTH LONGITUDINAL TENSILE SPECIMENS FROM AIR MELT-DEGAS-VAR BILLET

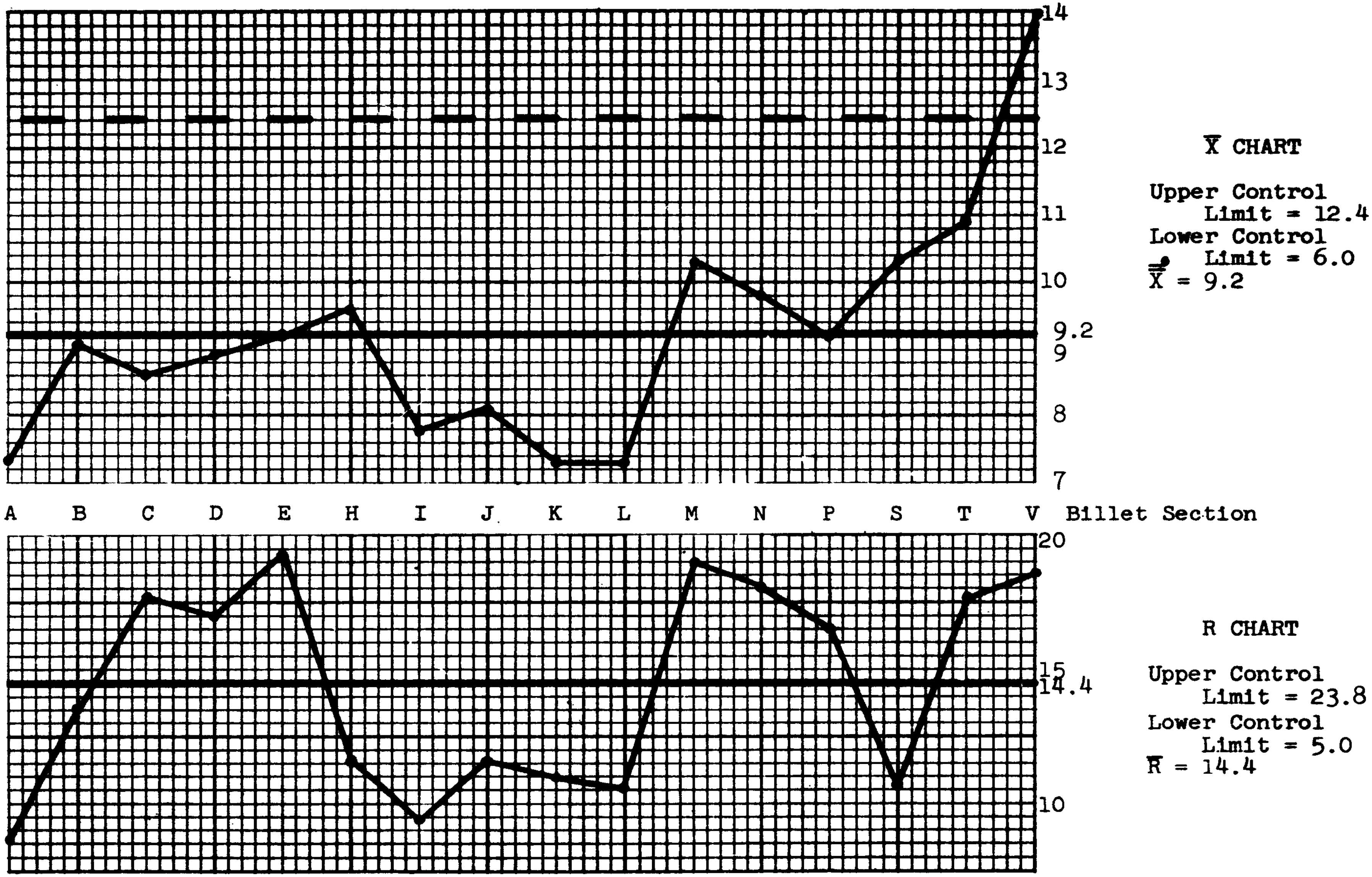


FIGURE 6-20

CONTROL CHART FOR PER CENT REDUCTION IN AREA OF SMOOTH LONGITUDINAL TENSILE SPECIMENS FROM AIR MELT-DEGAS-VAR BILLET

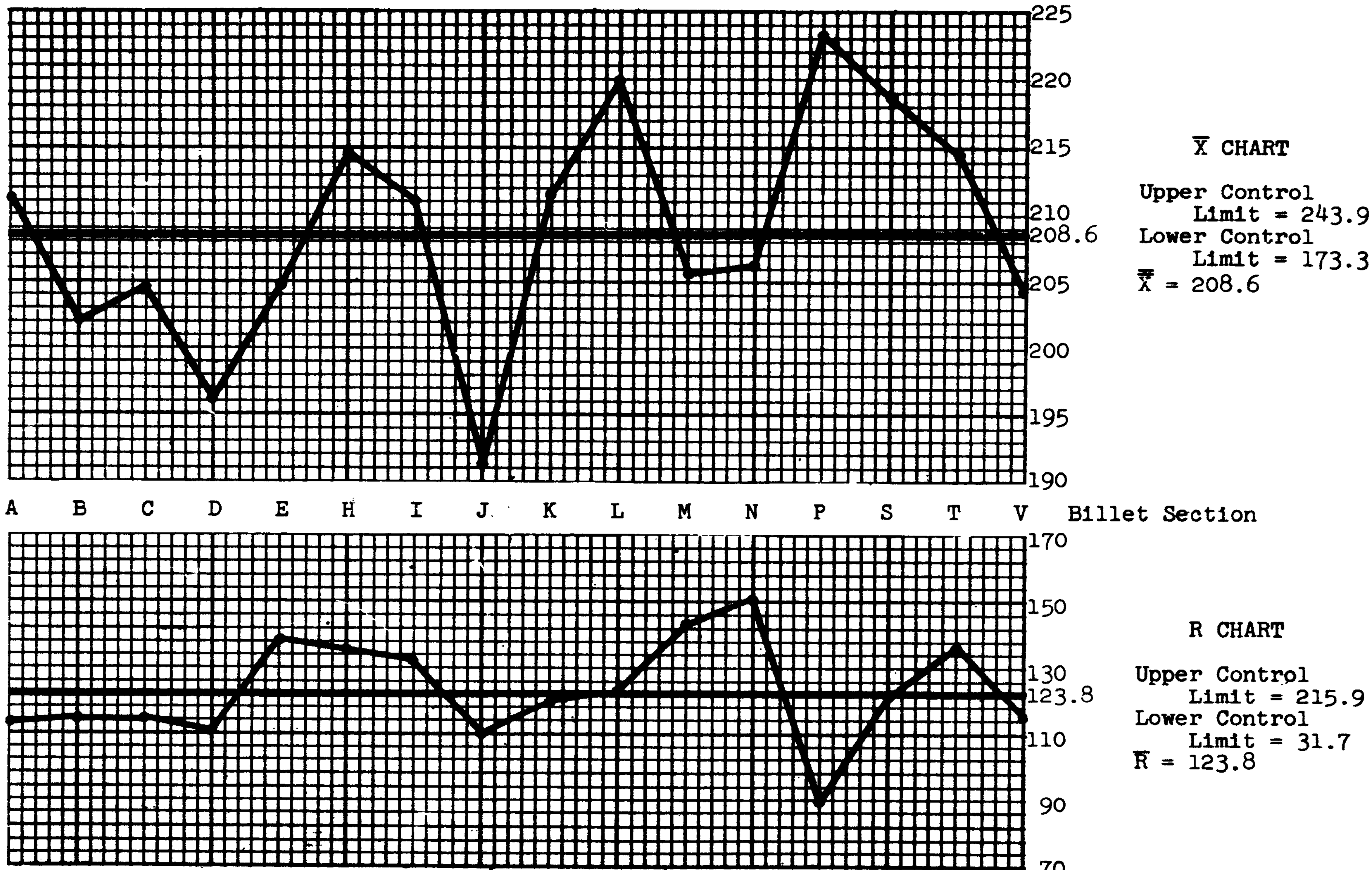


FIGURE 6-21

CONTROL CHART FOR ULTIMATE STRENGTH OF NOTCHED TRANSVERSE TENSILE SPECIMENS FROM AIR MELT-DEGAS-VAR BILLET

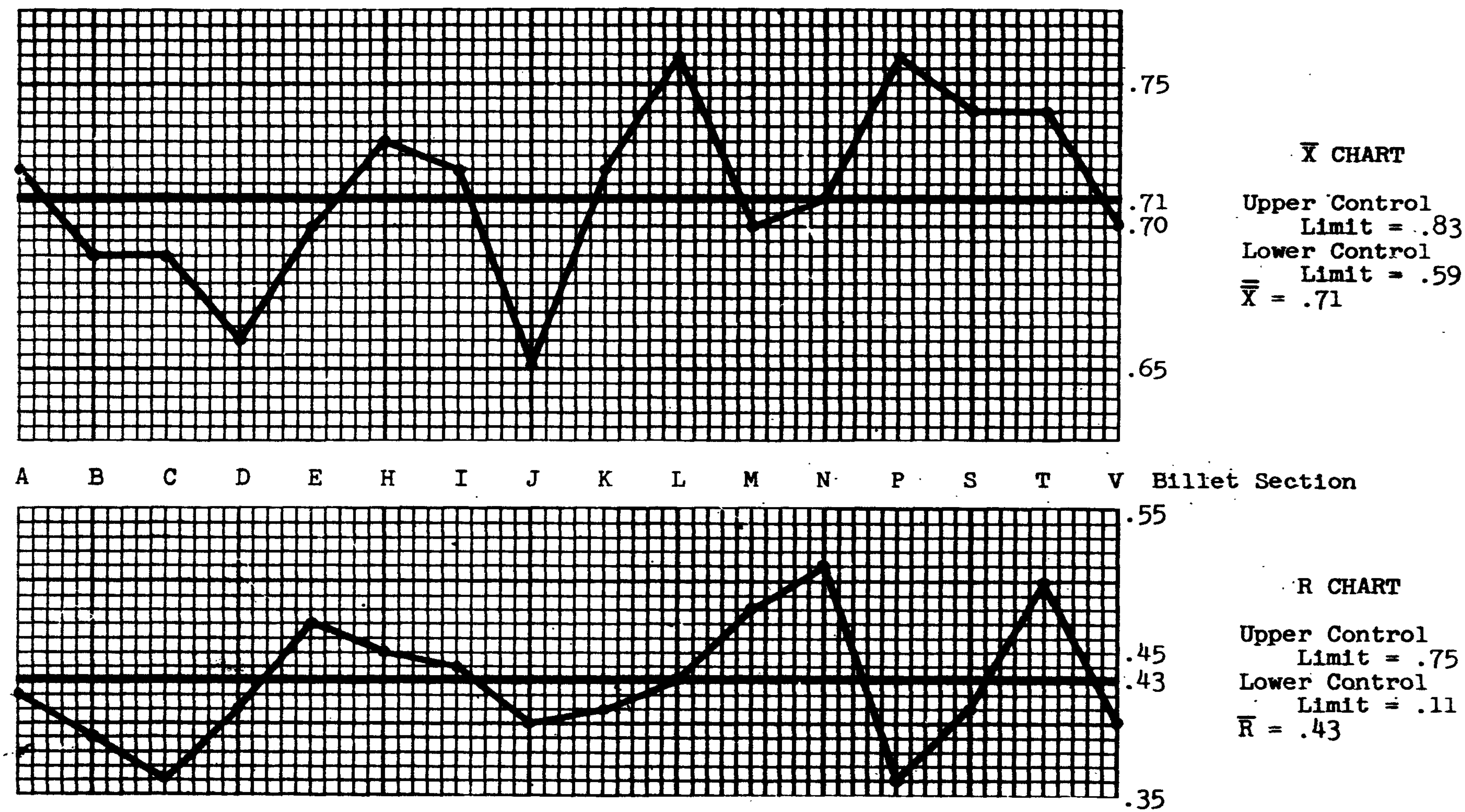


FIGURE 6-22

CONTROL CHART FOR N/S STRENGTH RATIO OF TRANSVERSE TENSILE SPECIMENS FROM AIR MELT-DEGAS-VAR BILLET

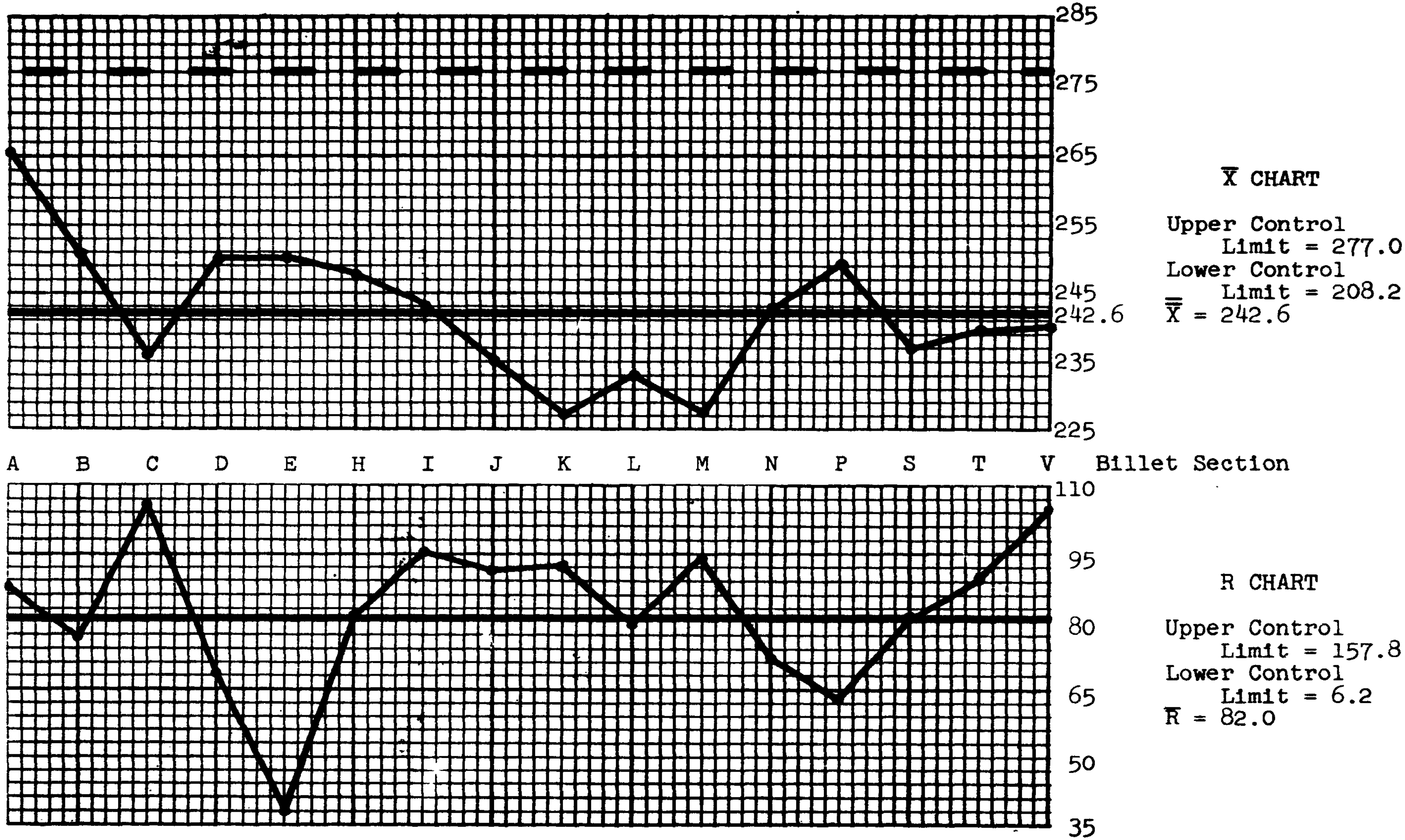


FIGURE 6-23

CONTROL CHART FOR ULTIMATE STRENGTH OF NOTCHED LONGITUDINAL TENSILE SPECIMENS FROM AIR MELT-DEGAS-VAR BILLET

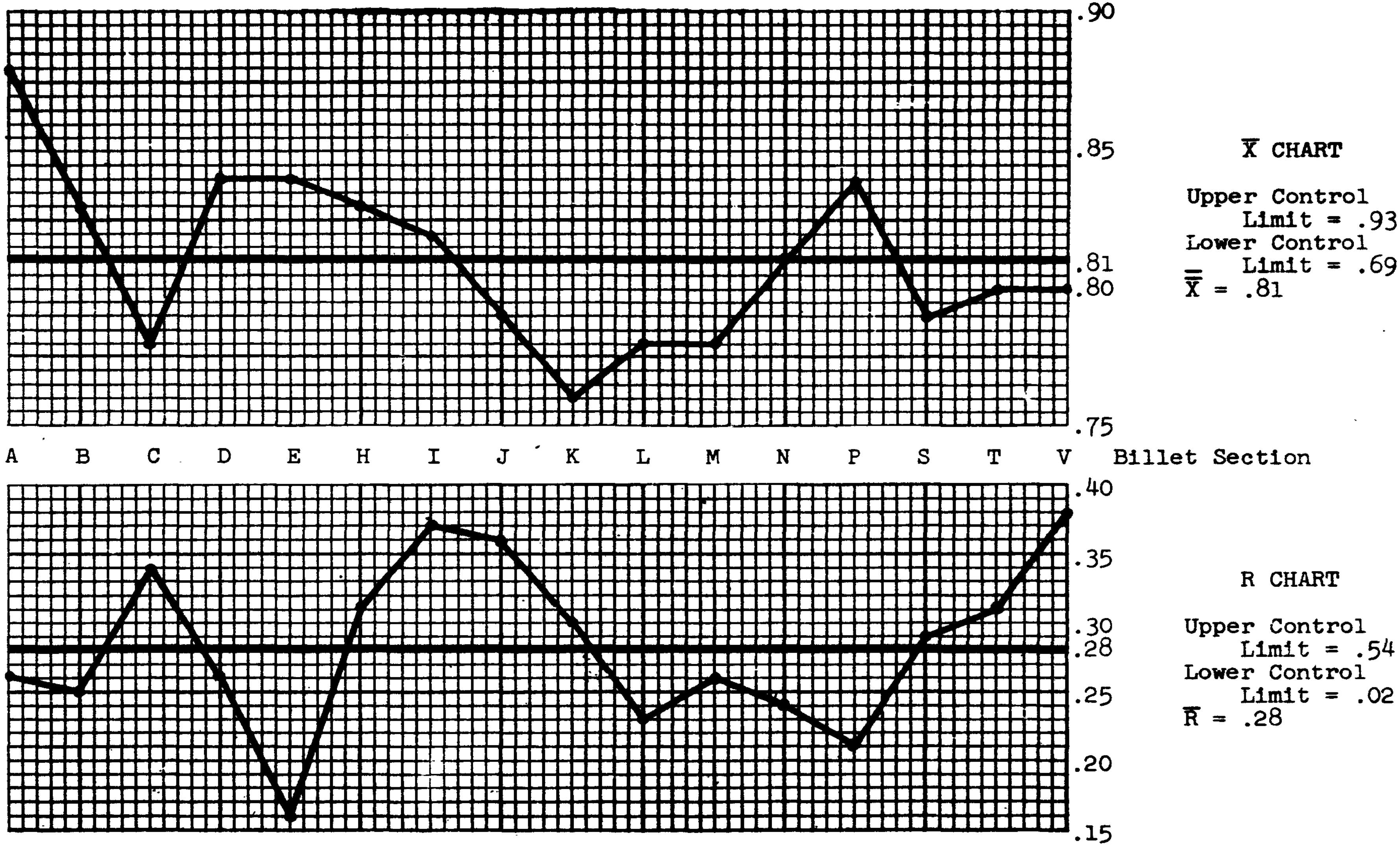


FIGURE 6-24

CONTROL CHART FOR N/S STRENGTH RATIO OF LONGITUDINAL TENSILE SPECIMENS FROM AIR MELT-DEGAS-VAR BILLET

SECTION 3

ARITHMETIC MEAN AND RANGE
CONTROL CHARTS FOR TENSILE
PROPERTIES OF AIR MELT-DOUBLE VAR
HEAT W-24341-2

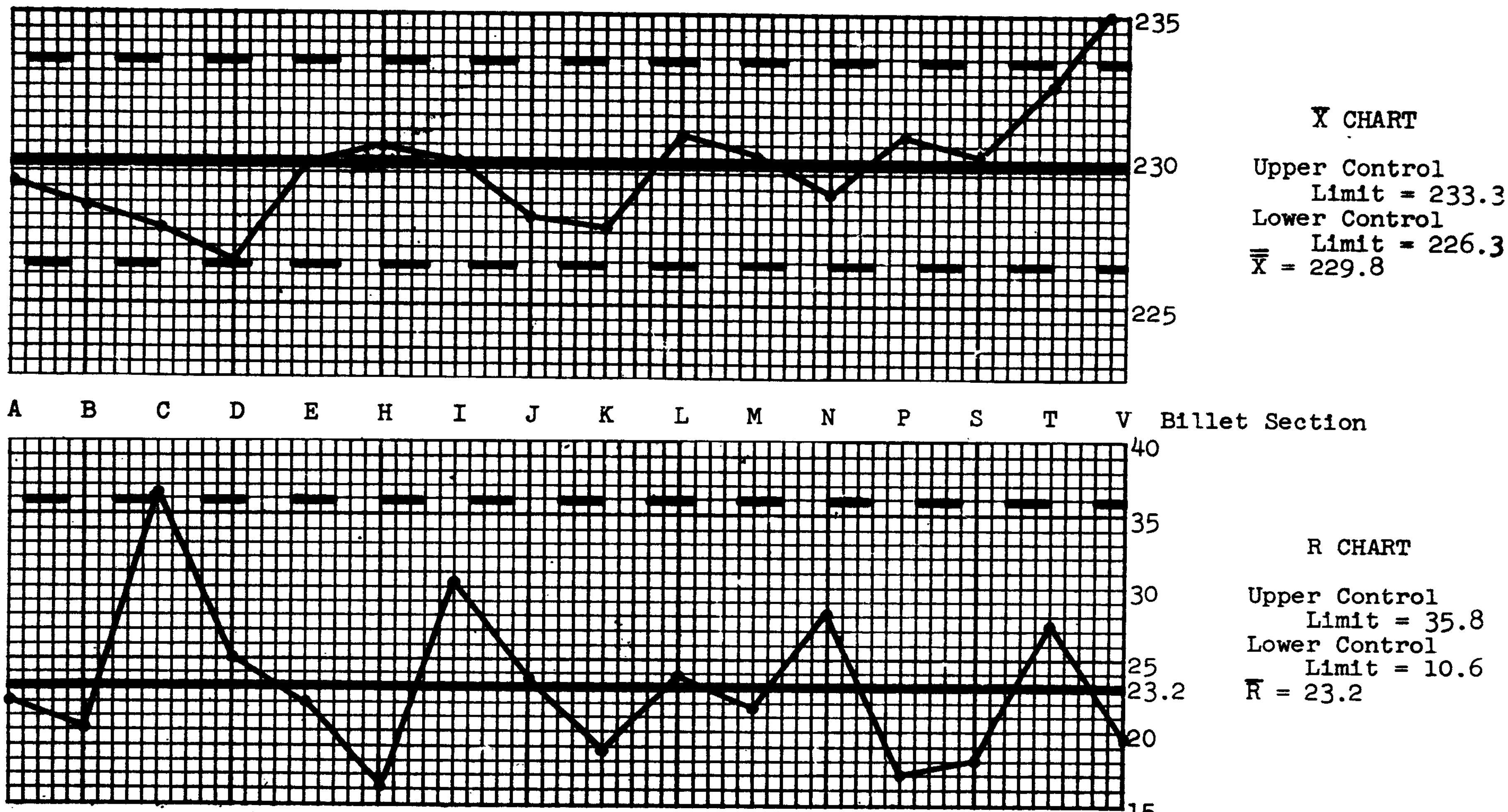
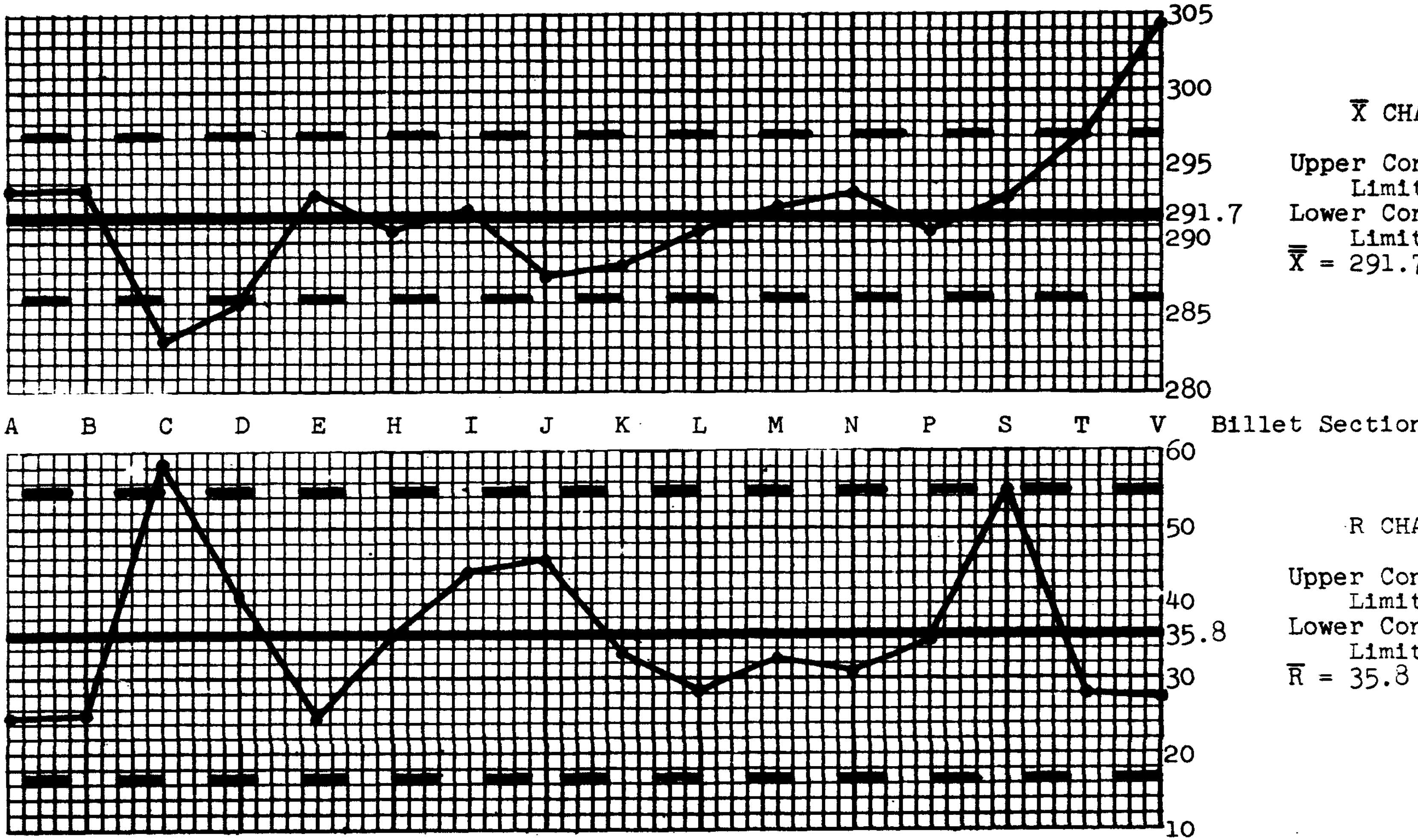


FIGURE 6-25

CONTROL CHART FOR YIELD STRENGTH OF SMOOTH TRANSVERSE TENSILE SPECIMENS FROM AIR MELT-DOUBLE VAR BILLET



$\overline{X}$ CHART

Upper Control Limit = 297.2
Lower Control Limit = 286.2
$\overline{\overline{X}}$ = 291.7

R CHART

Upper Control Limit = 55.2
Lower Control Limit = 16.4
$\overline{R}$ = 35.8

FIGURE 6-26

CONTROL CHART FOR ULTIMATE STRENGTH OF SMOOTH TRANSVERSE TENSILE SPECIMENS FROM AIR MELT-DOUBLE VAR BILLET

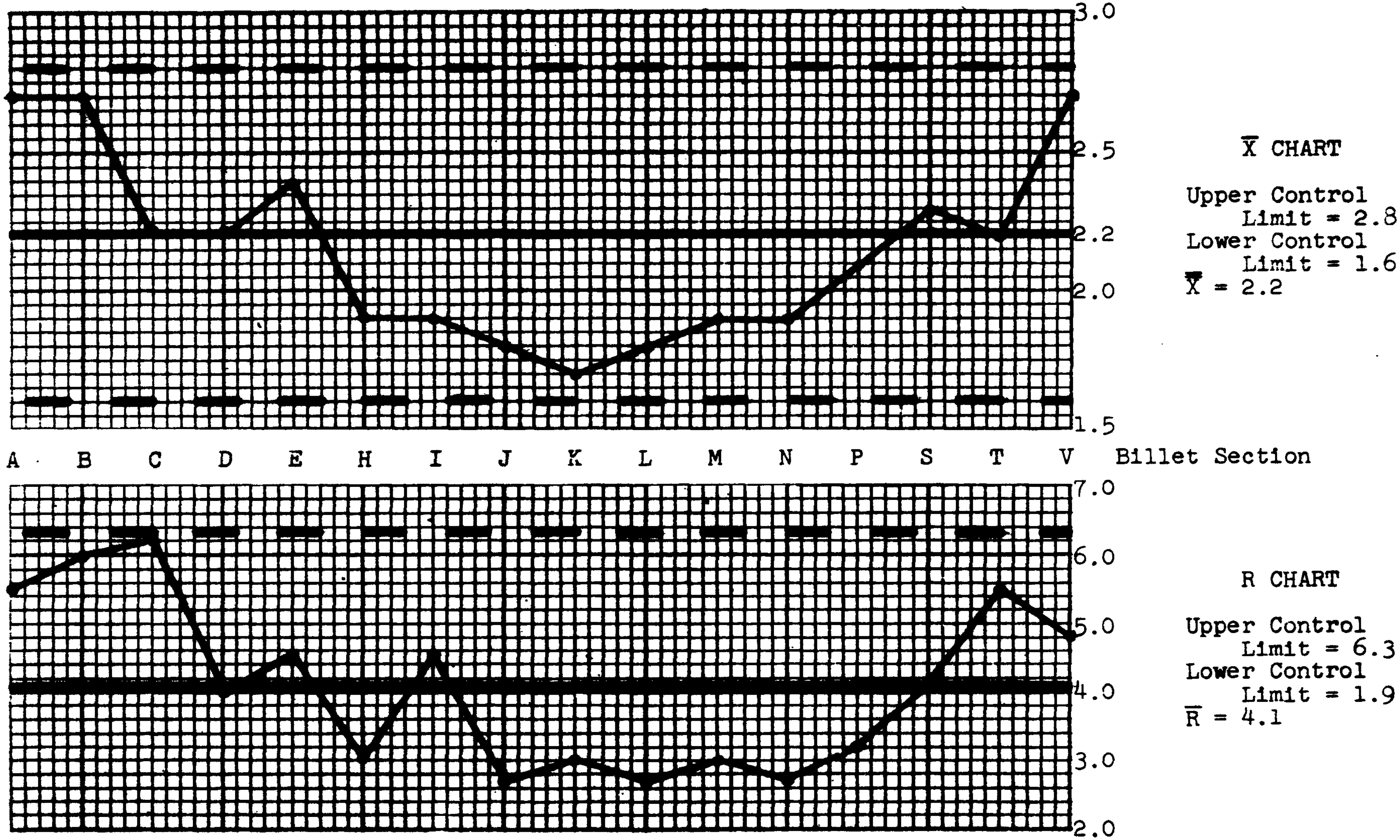


FIGURE 6-27

CONTROL CHART FOR PER CENT ELONGATION OF SMOOTH TRANSVERSE TENSILE SPECIMENS FROM AIR MELT-DOUBLE VAR BILLET

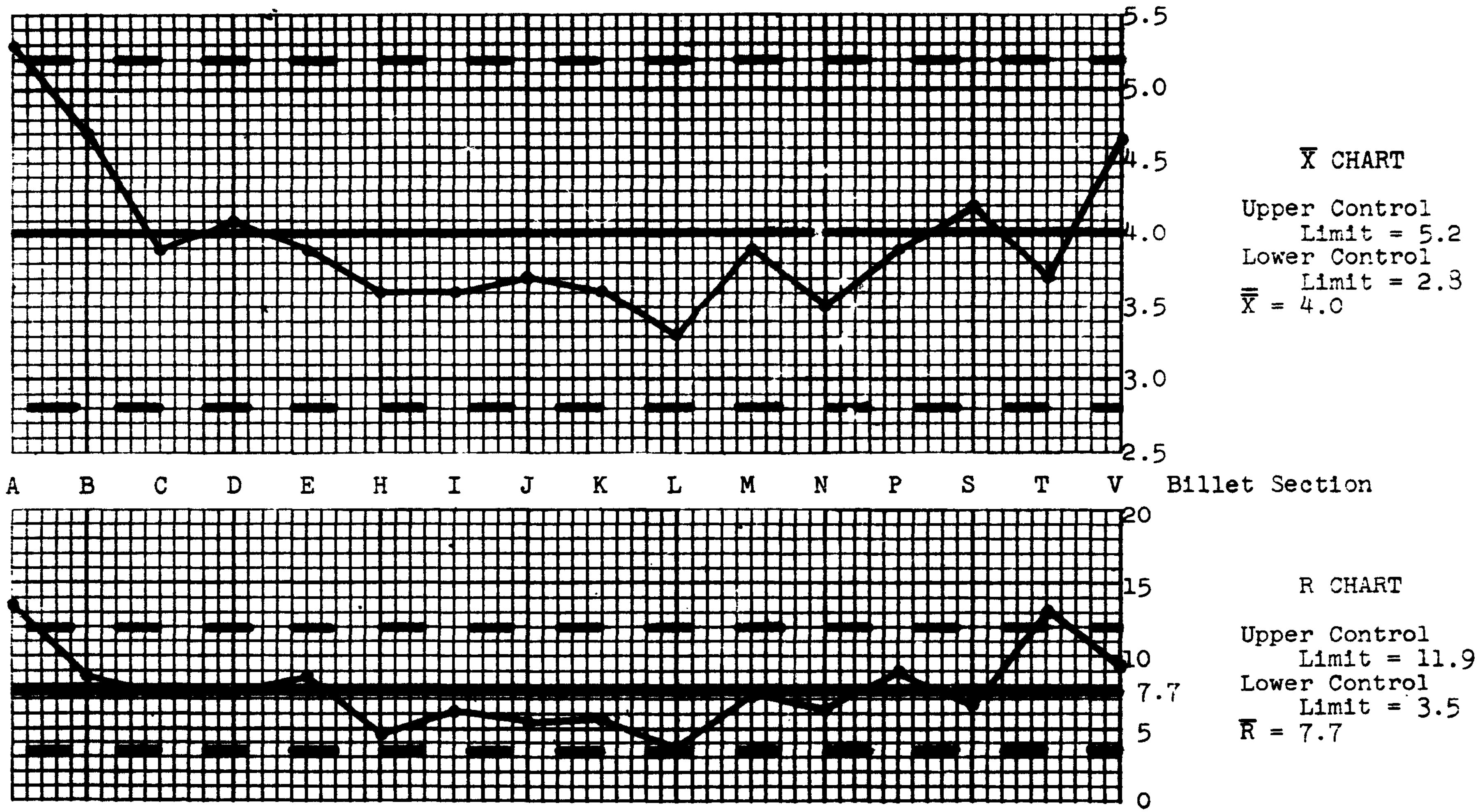


FIGURE 6-28

CONTROL CHART FOR PER CENT REDUCTION IN AREA OF SMOOTH TRANSVERSE TENSILE SPECIMENS FROM AIR MELT-DOUBLE VAR BILLET

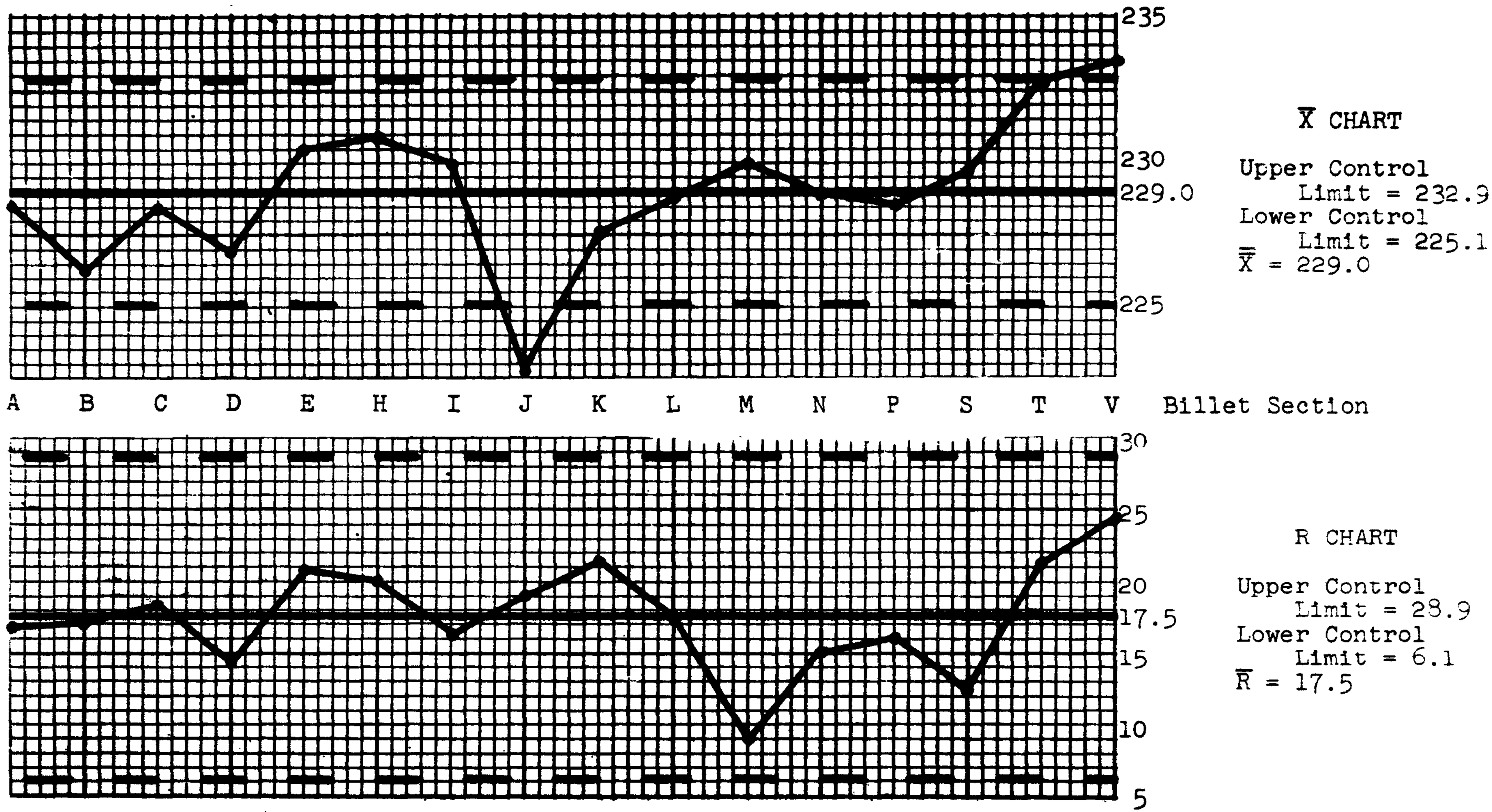


FIGURE 6-29

CONTROL CHART FOR YIELD STRENGTH OF SMOOTH LONGITUDINAL TENSILE SPECIMENS FROM AIR MELT-DOUBLE VAR BILLET

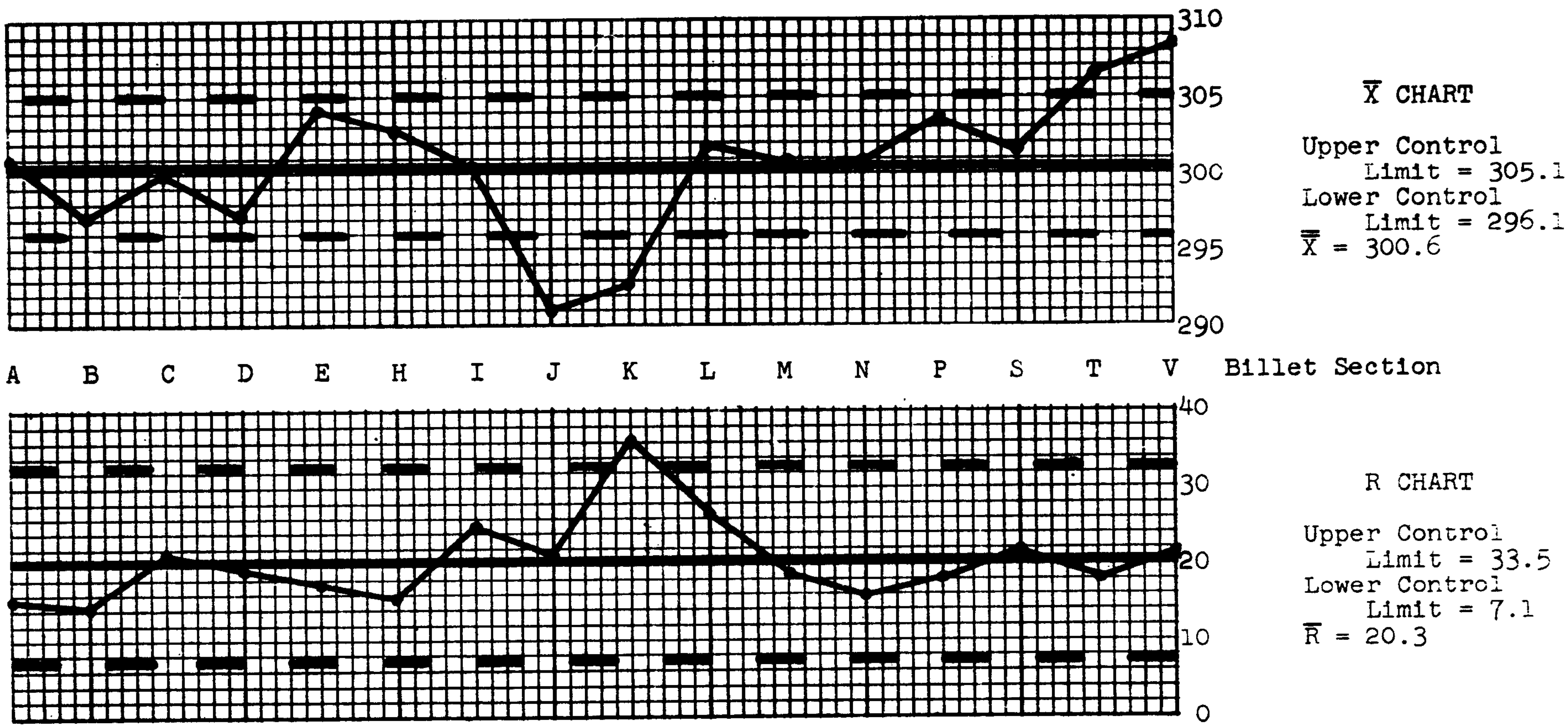


FIGURE 6-30

CONTROL CHART FOR ULTIMATE STRENGTH OF SMOOTH LONGITUDINAL TENSILE SPECIMENS FROM AIR MELT-DOUBLE VAR BILLET

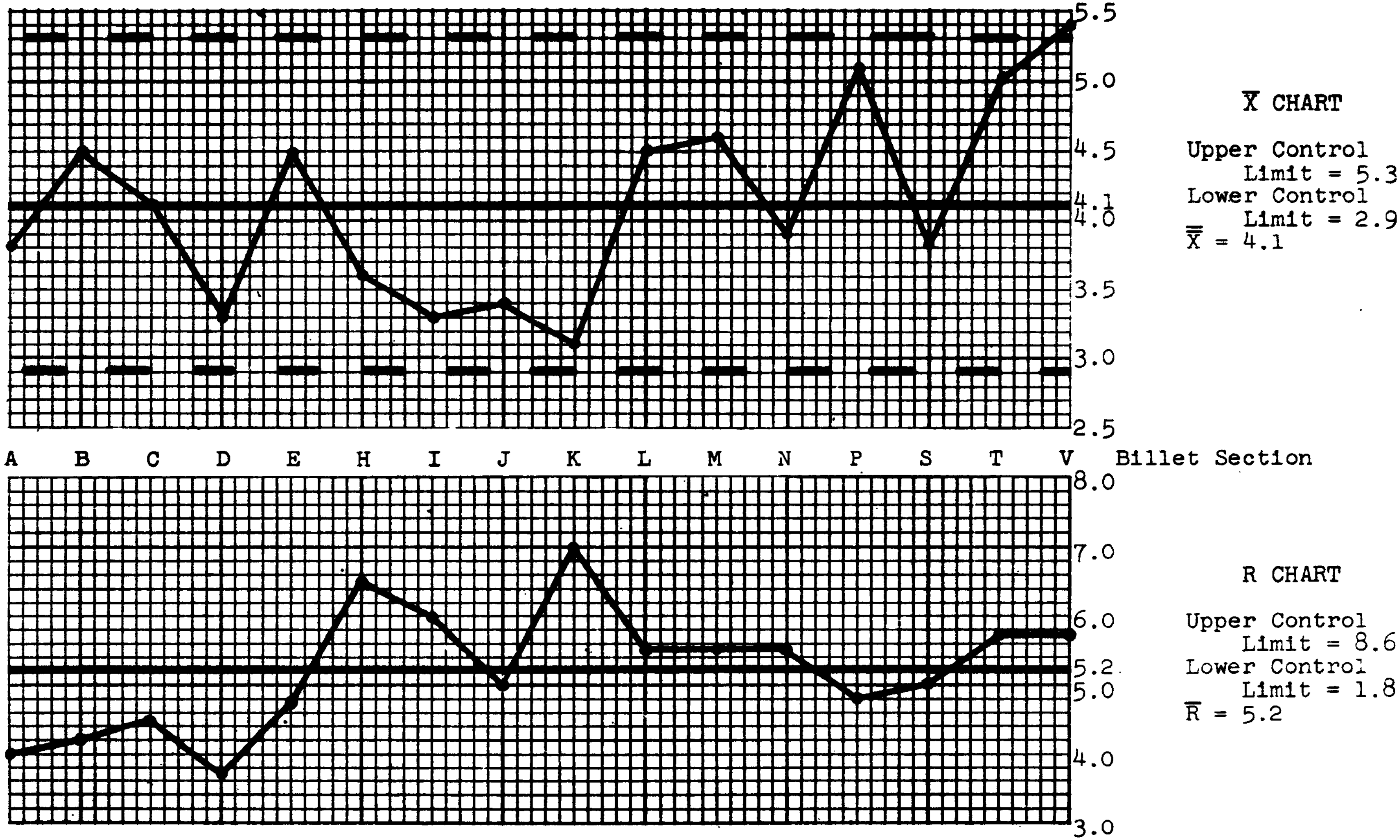


FIGURE 6-31

CONTROL CHART FOR PER CENT ELONGATION OF SMOOTH LONGITUDINAL TENSILE SPECIMENS FROM AIR MELT-DOUBLE VAR BILLET

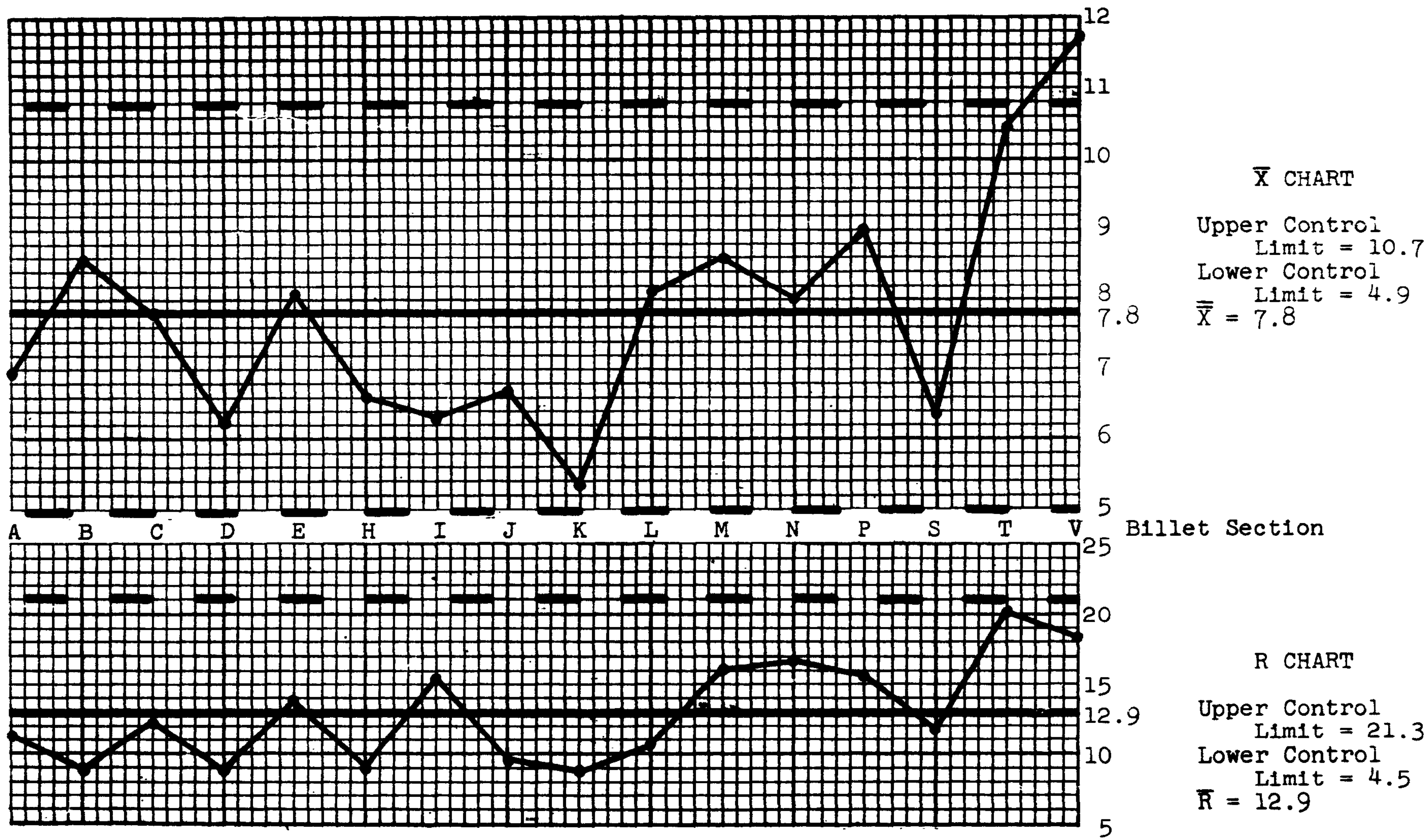


FIGURE 6-32

CONTROL CHART FOR PER CENT REDUCTION IN AREA OF SMOOTH LONGITUDINAL TENSILE SPECIMENS FROM AIR MELT-DOUBLE VAR BILLET

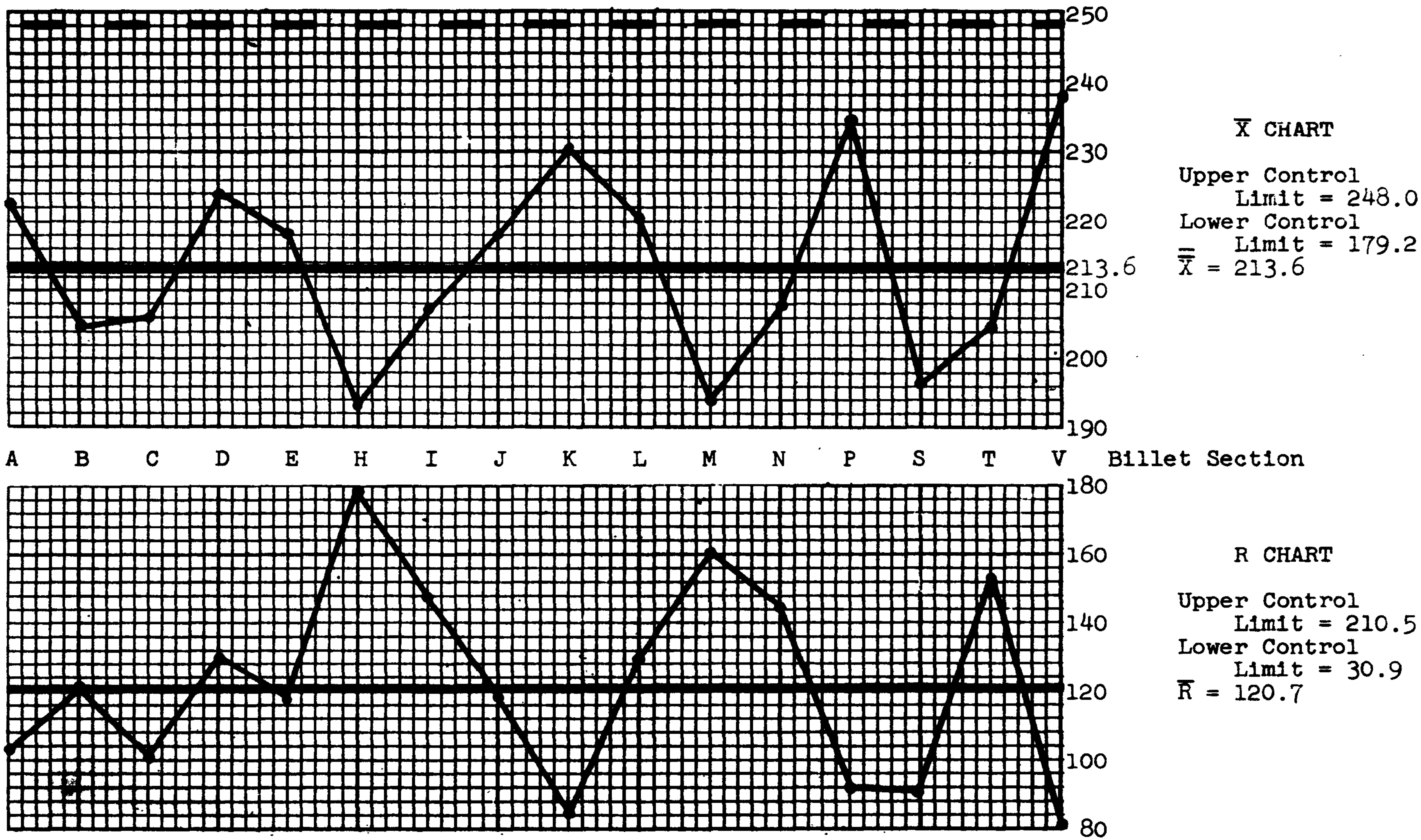


FIGURE 6-33

CONTROL CHART FOR ULTIMATE STRENGTH OF NOTCHED TRANSVERSE TENSILE SPECIMENS FROM AIR MELT-DOUBLE VAR BILLET

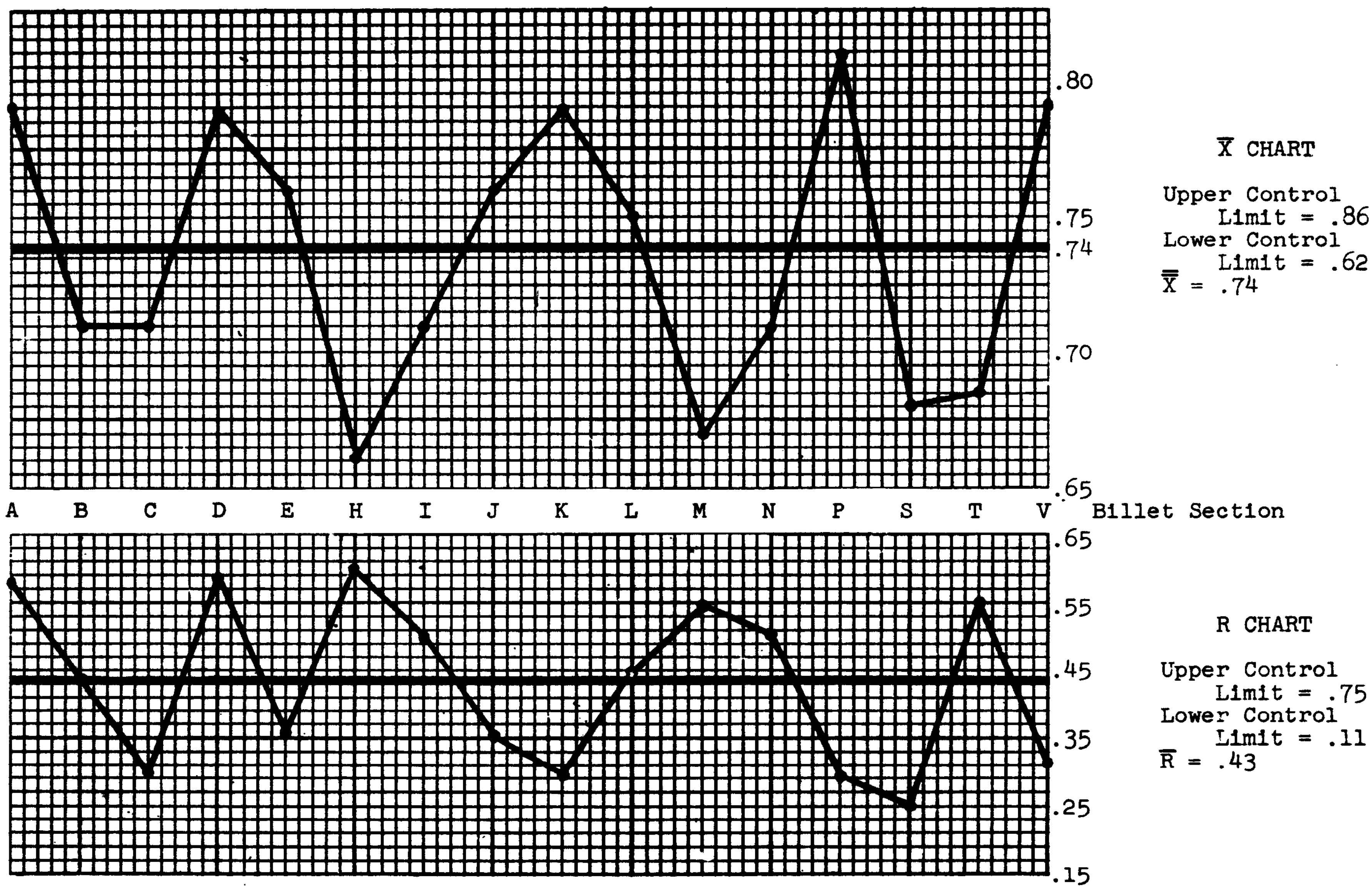


FIGURE 6-34

CONTROL CHART FOR N/S STRENGTH RATIO OF TRANSVERSE TENSILE SPECIMENS FROM AIR MELT-DOUBLE VAR BILLET

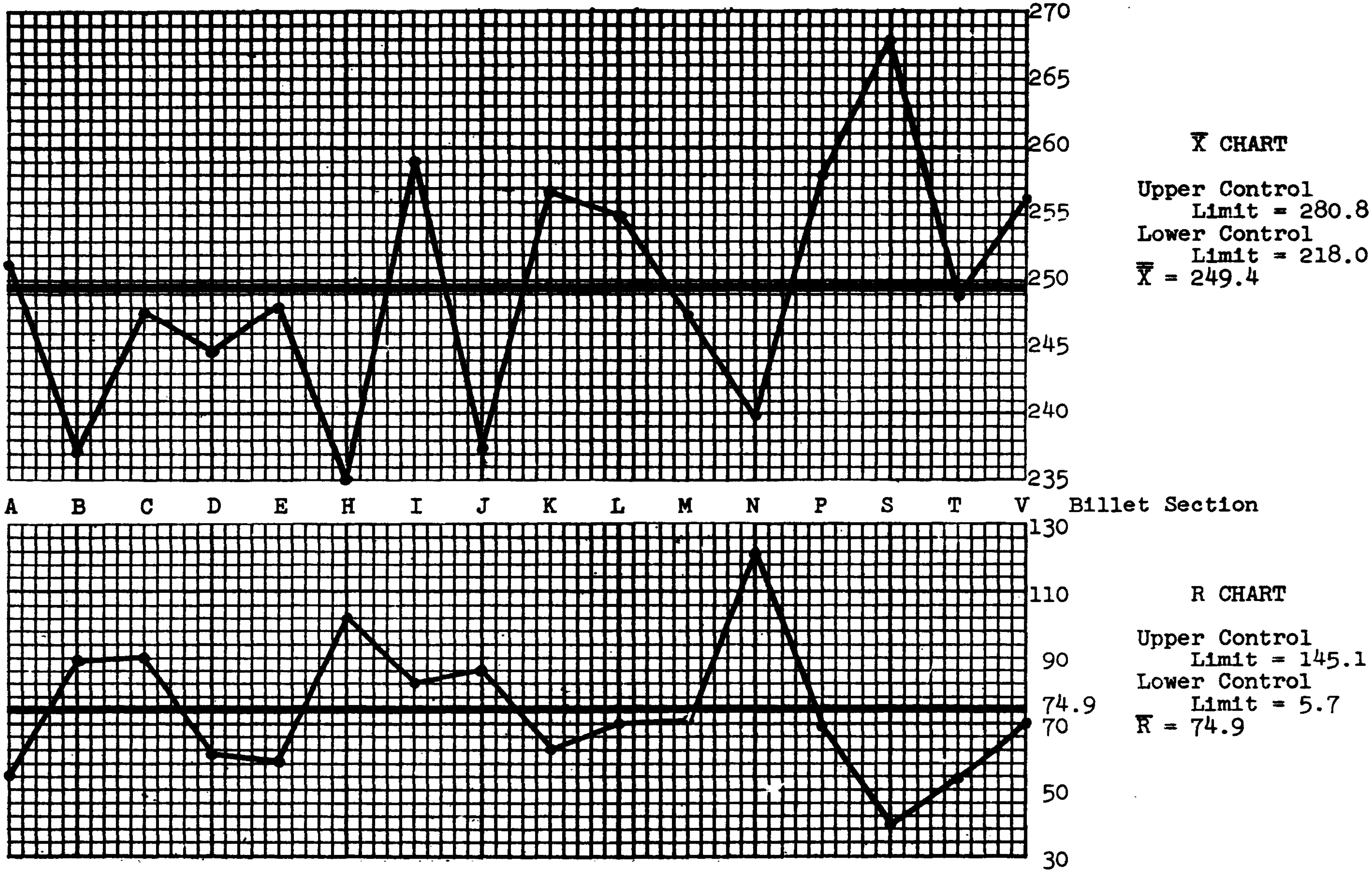


FIGURE 6-35

CONTROL CHART FOR ULTIMATE STRENGTH OF NOTCHED LONGITUDINAL TENSILE SPECIMENS FROM AIR MELT-DOUBLE VAR BILLET

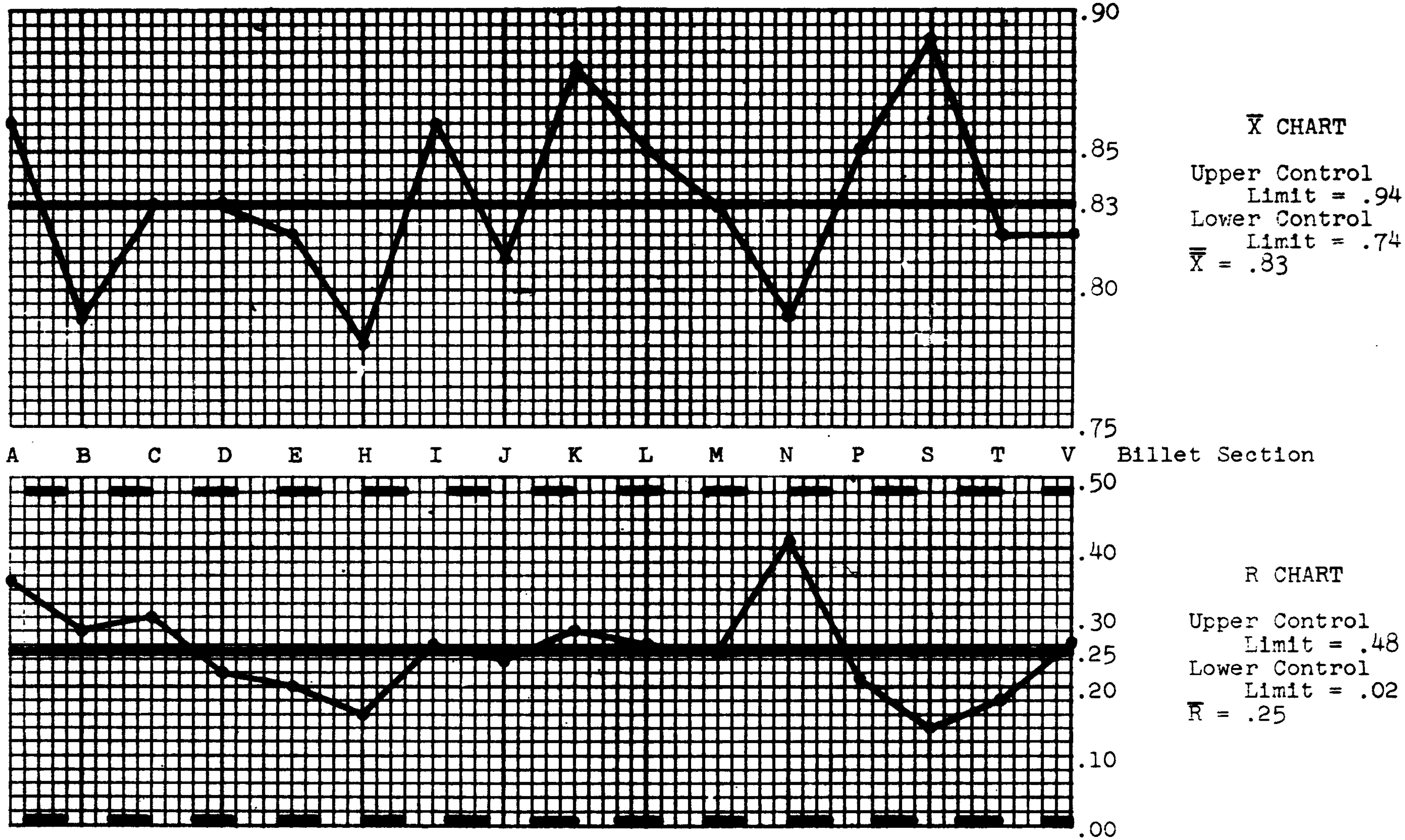


FIGURE 6-36

CONTROL CHART FOR N/S STRENGTH RATIO OF LONGITUDINAL TENSILE SPECIMENS FROM AIR MELT-DOUBLE VAR BILLET

SECTION 4

ARITHMETIC MEAN AND RANGE CONTROL CHARTS FOR TENSILE PROPERTIES OF VACUUM INDUCTION MELT-VAR HEAT W-24403-1

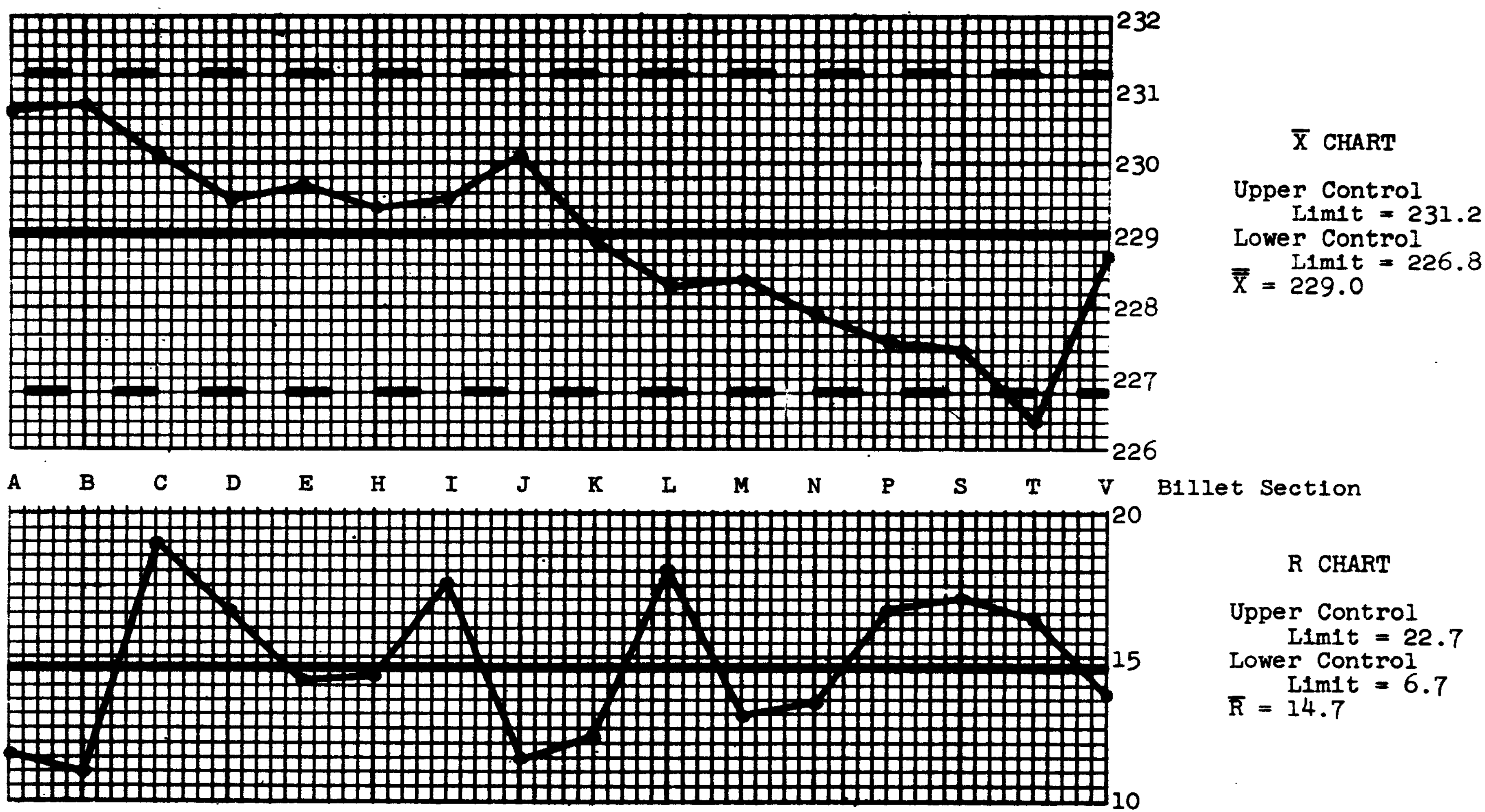


FIGURE 6-37

CONTROL CHART FOR YIELD STRENGTH OF SMOOTH TRANSVERSE TENSILE SPECIMENS FROM VACUUM INDUCTION MELT-VAR BILLET

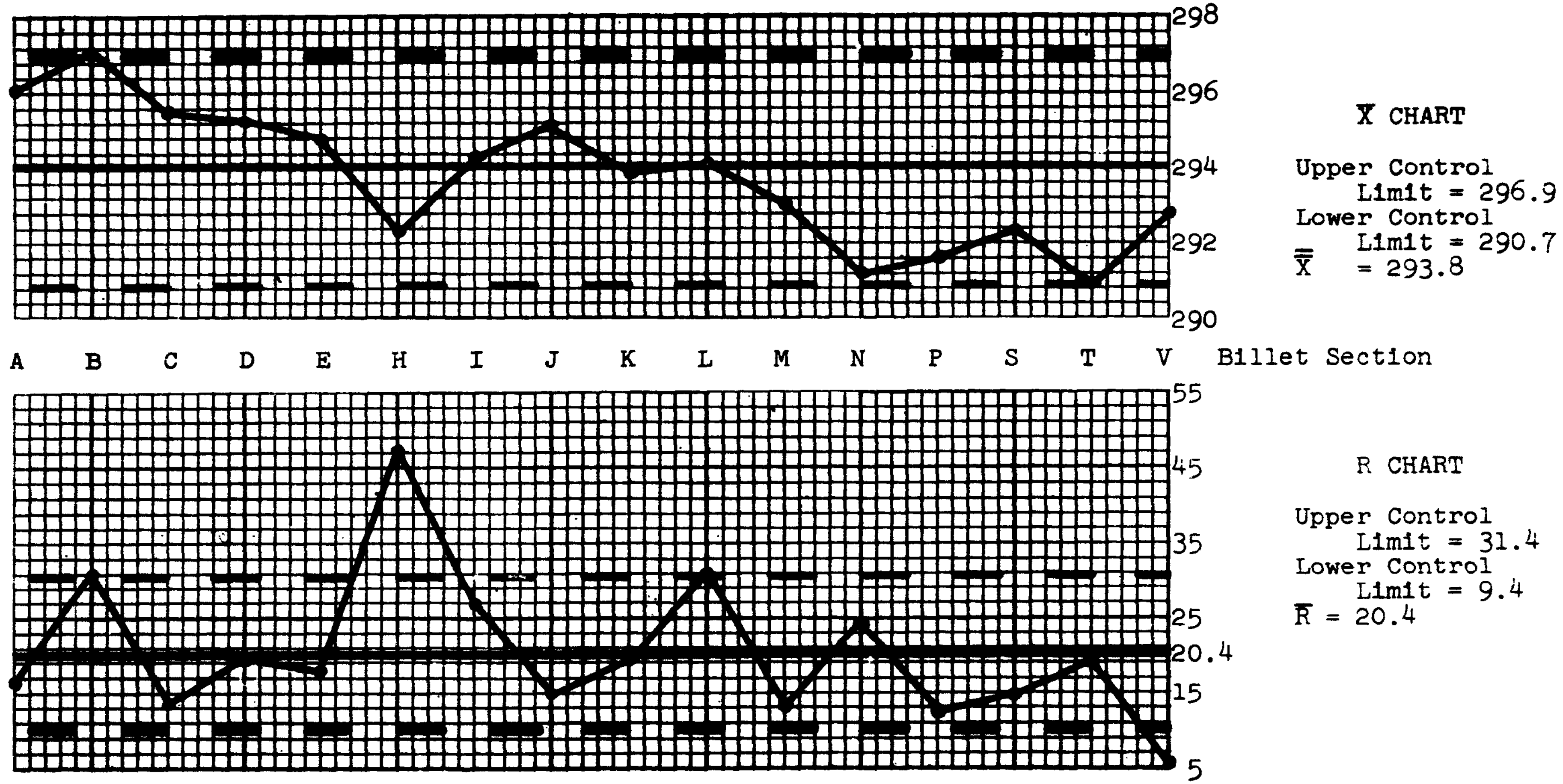


FIGURE 6-38

CONTROL CHART FOR ULTIMATE STRENGTH OF SMOOTH TRANSVERSE TENSILE SPECIMENS FROM VACUUM INDUCTION MELT-VAR BILLET

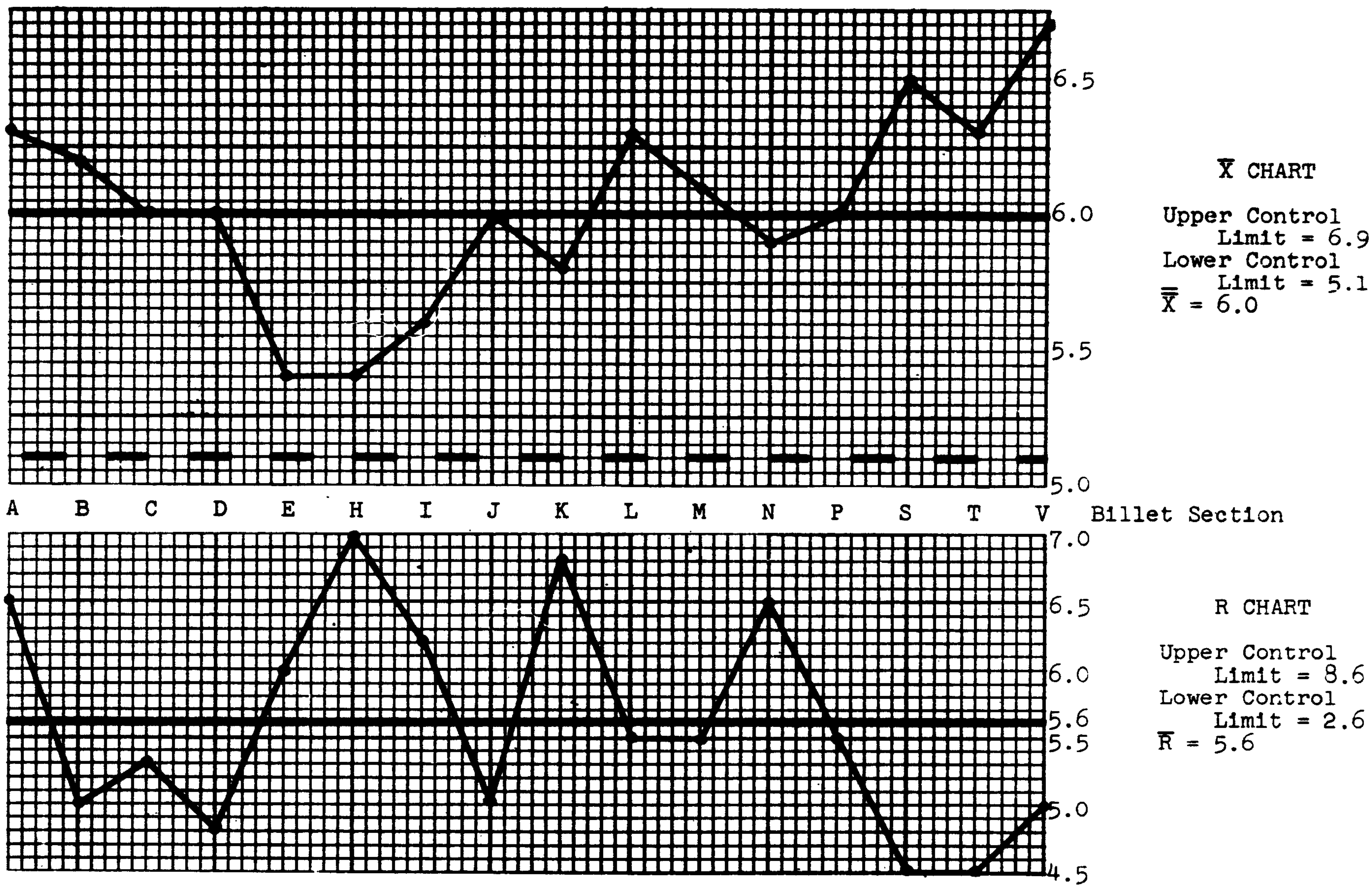


FIGURE 6-39

CONTROL CHART FOR PER CENT ELONGATION OF SMOOTH TRANSVERSE TENSILE SPECIMENS FROM VACUUM INDUCTION MELT-VAR BILLET

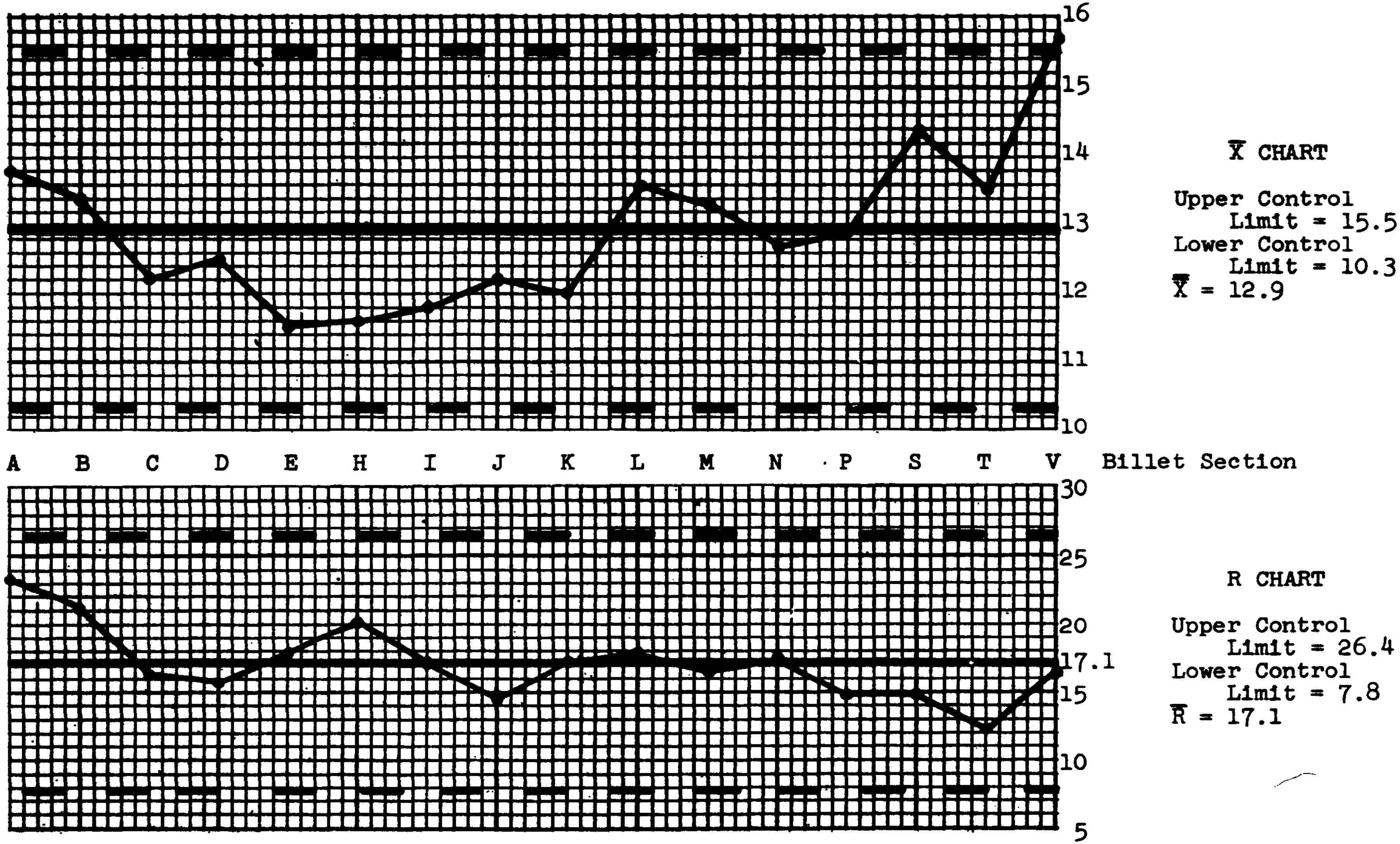


FIGURE 6-40

CONTROL CHART FOR PER CENT REDUCTION IN AREA OF SMOOTH TRANSVERSE TENSILE SPECIMENS FROM VACUUM INDUCTION MELT-VAR BILLET

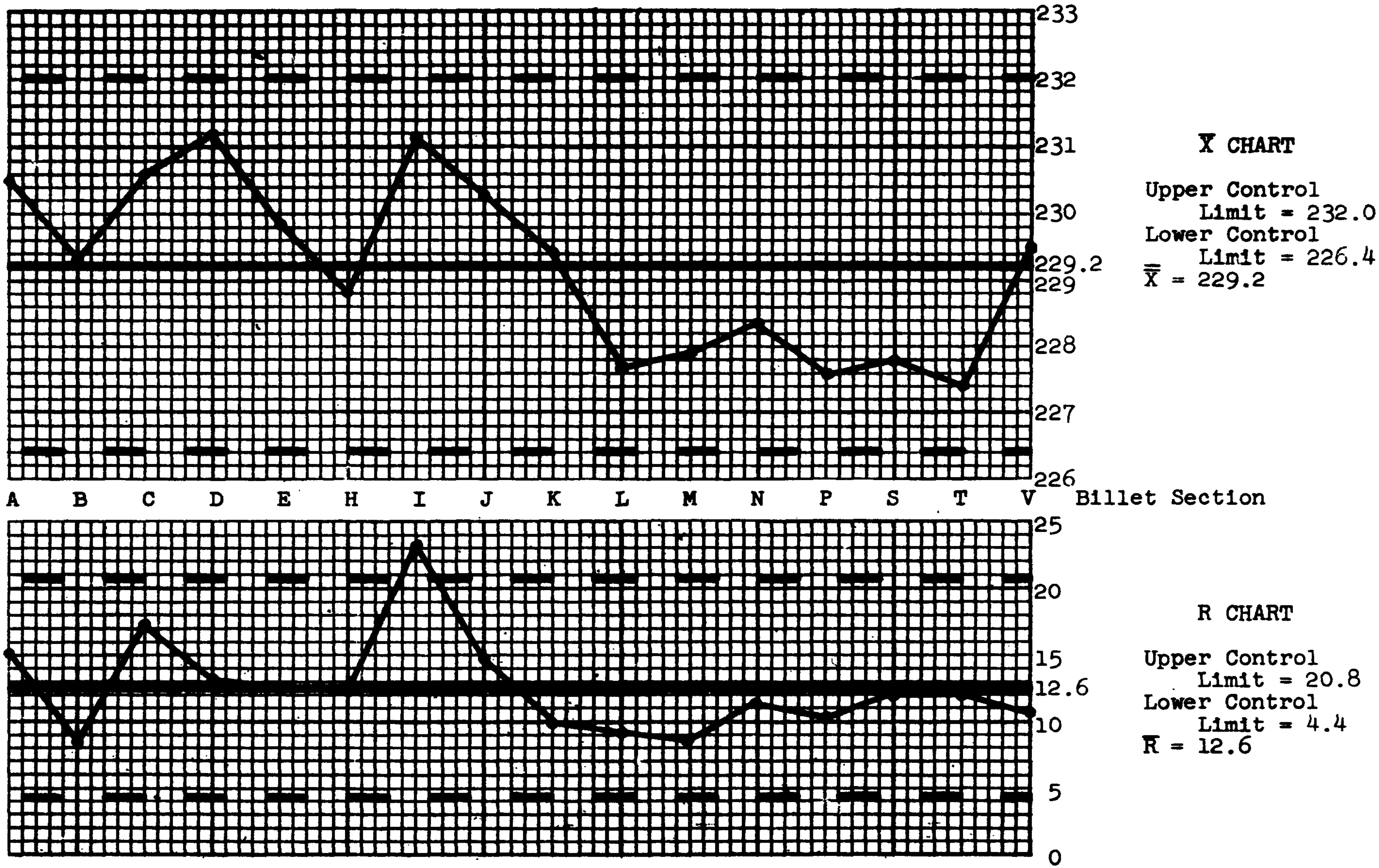


FIGURE 6-41

CONTROL CHART FOR YIELD STRENGTH OF SMOOTH LONGITUDINAL TENSILE SPECIMENS FROM VACUUM INDUCTION MELT-VAR BILLET

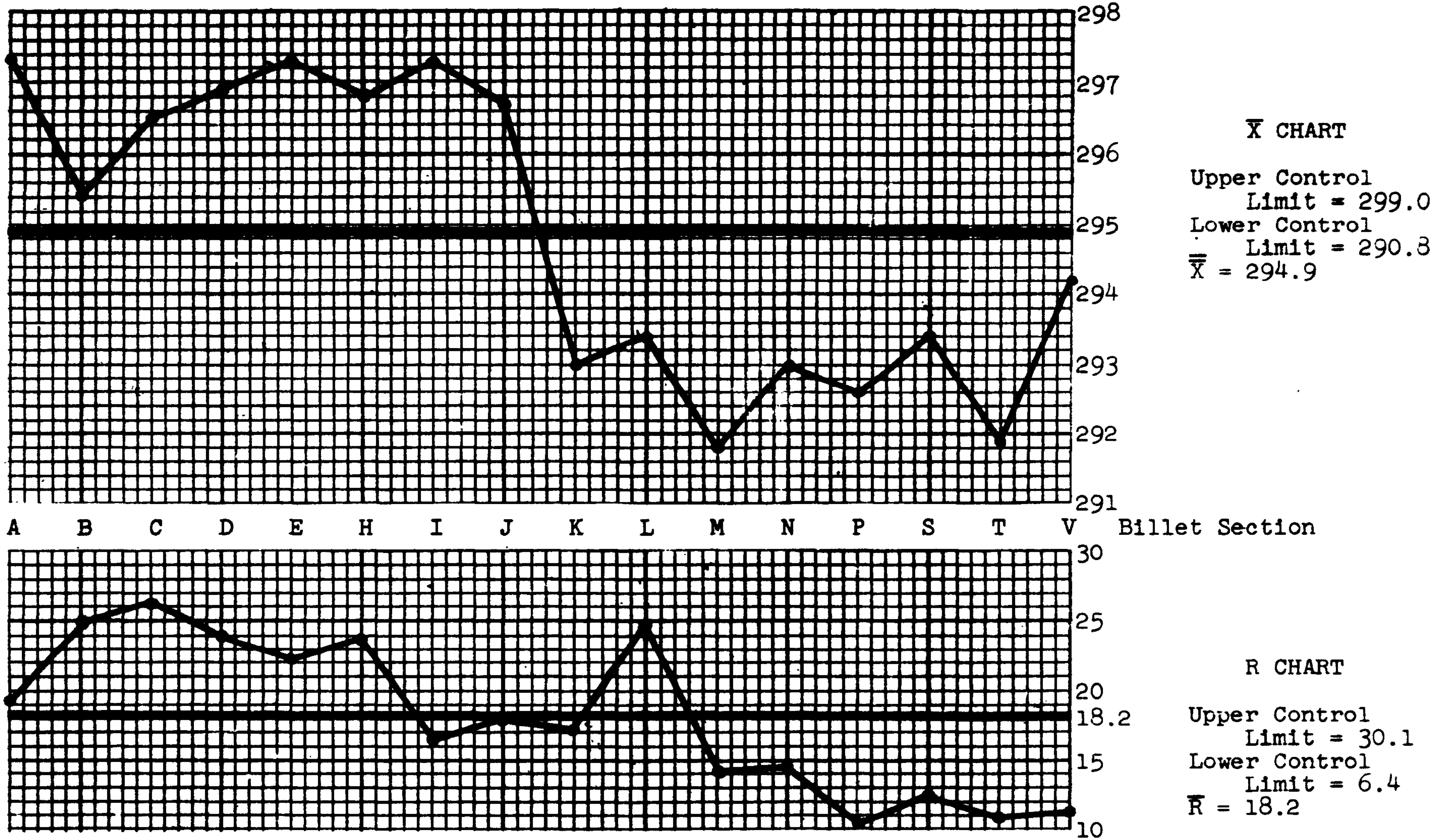


FIGURE 6-42

CONTROL CHART FOR ULTIMATE STRENGTH OF SMOOTH LONGITUDINAL TENSILE SPECIMENS FROM VACUUM INDUCTION MELT-VAR BILLET

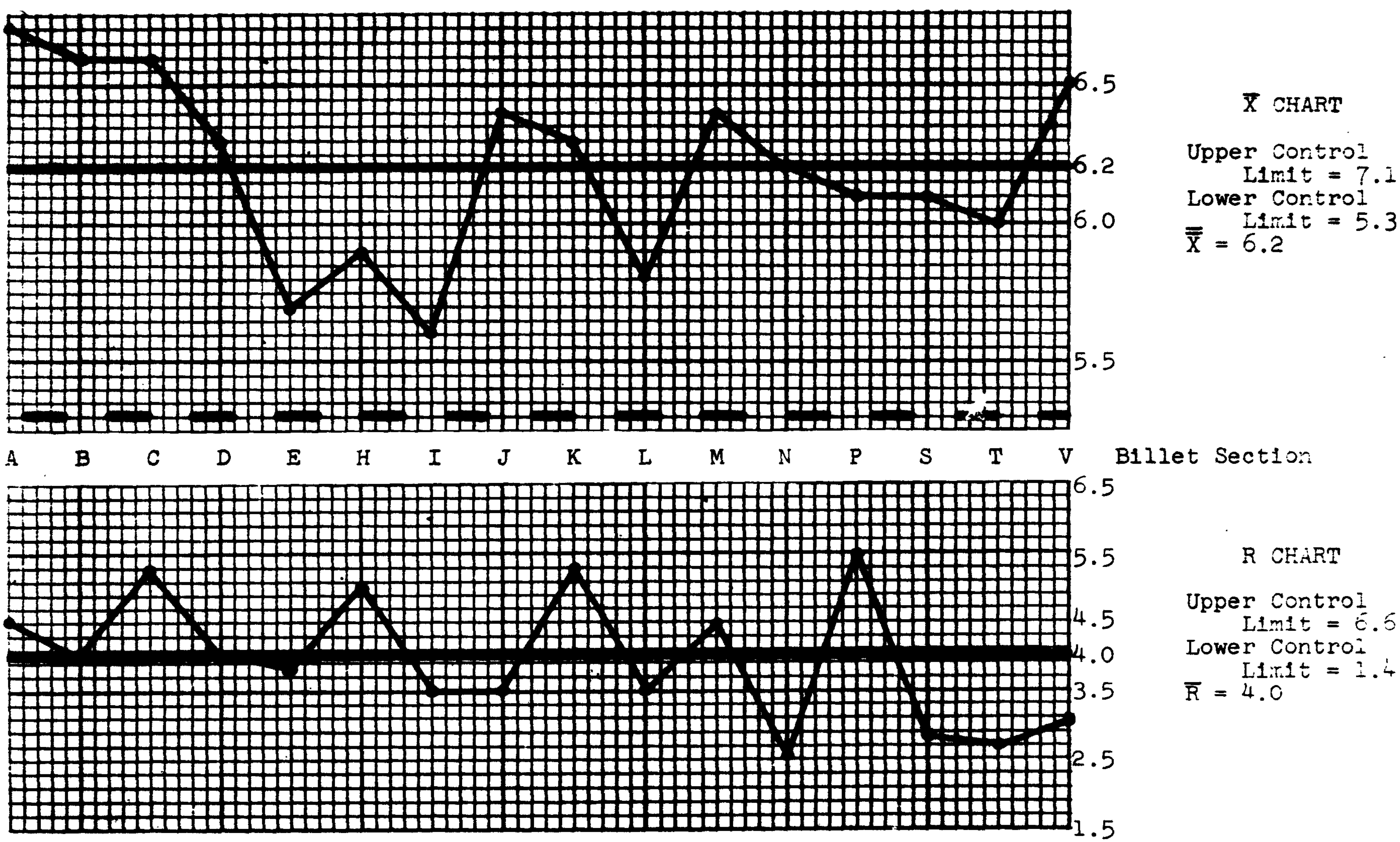


FIGURE 6-43

CONTROL CHART FOR PER CENT ELONGATION OF SMOOTH LONGITUDINAL TENSILE SPECIMENS FROM VACUUM INDUCTION MELT-VAR BILLET

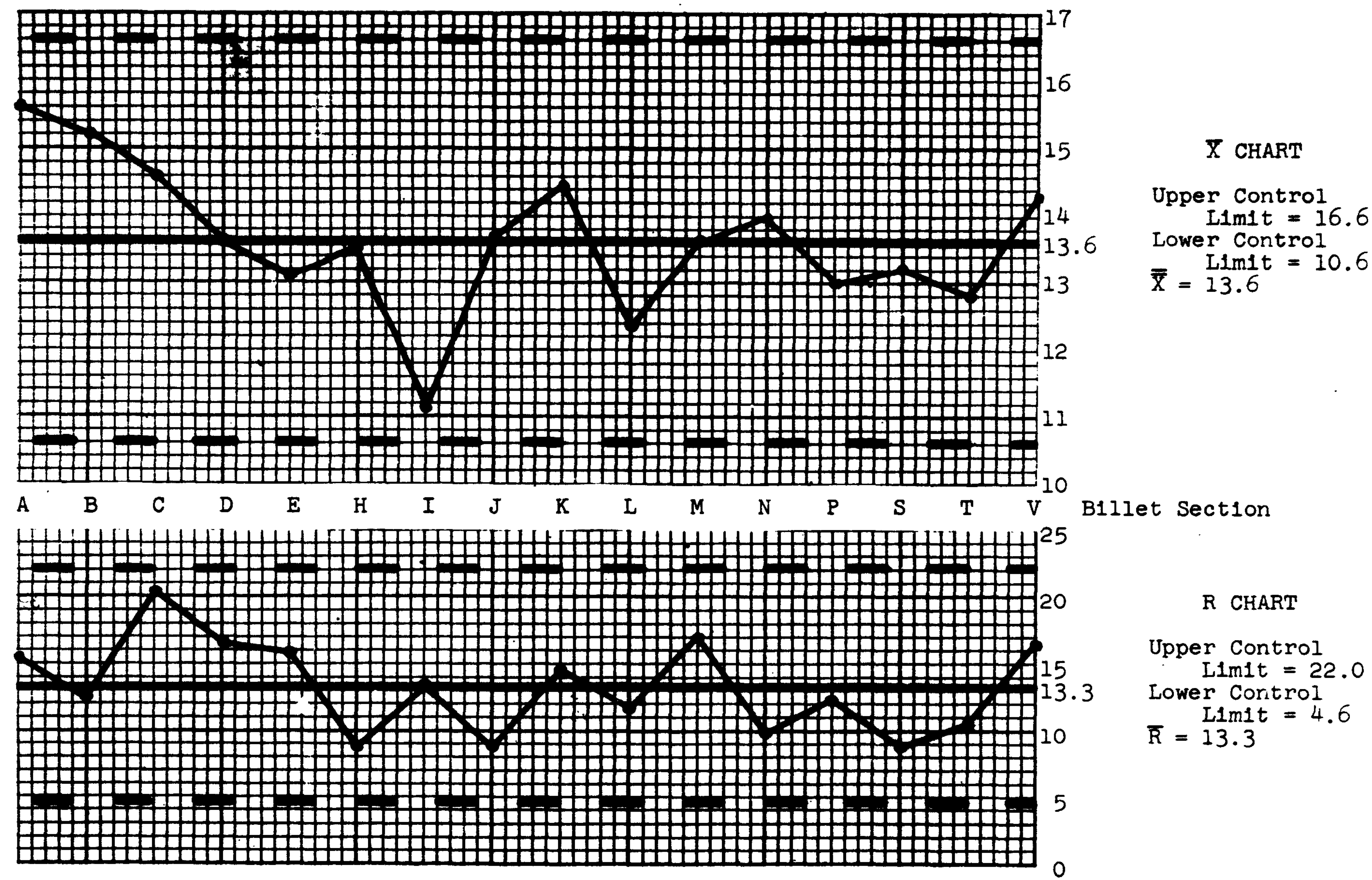
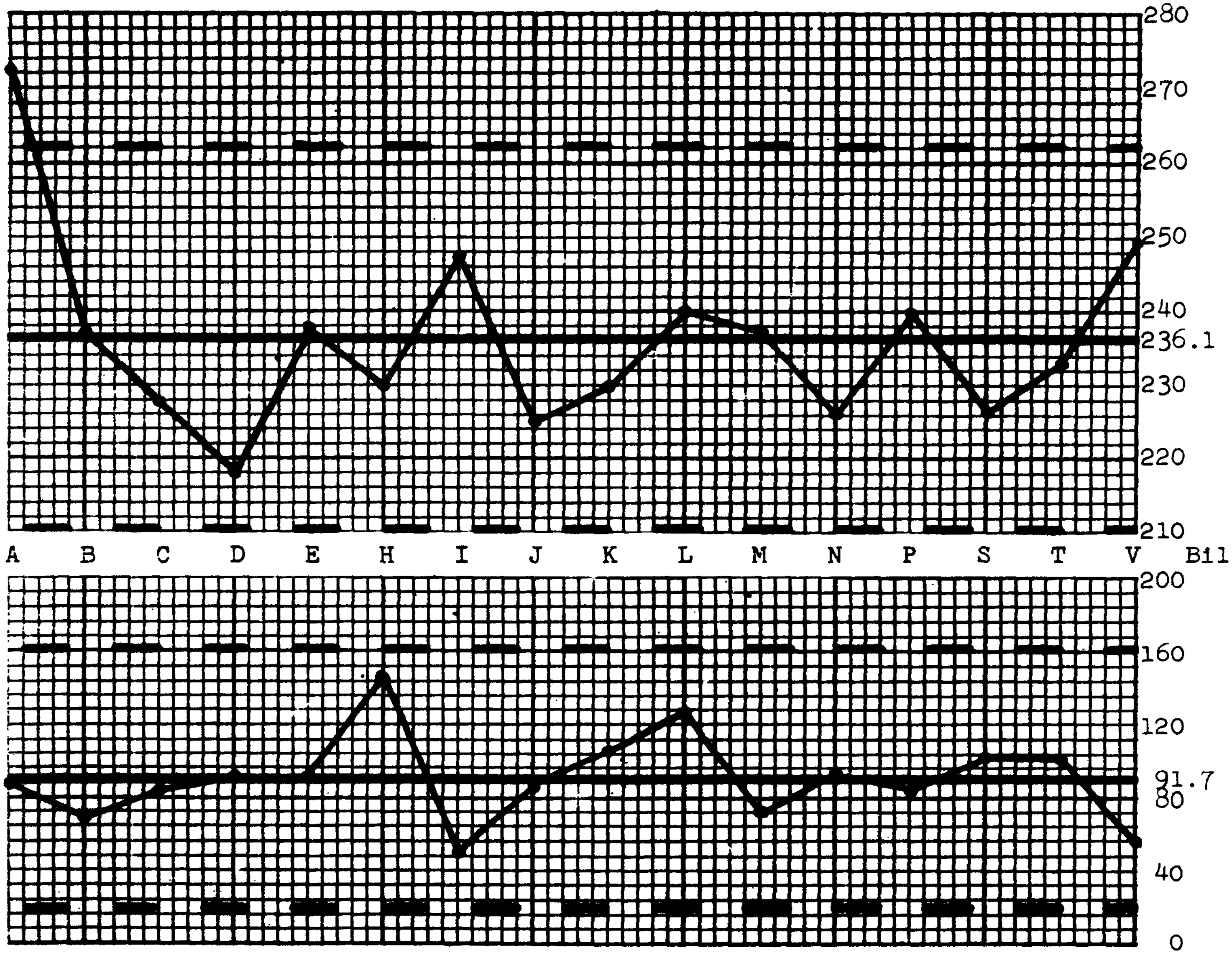


FIGURE 6-44

CONTROL CHART FOR PER CENT REDUCTION IN AREA OF SMOOTH LONGITUDINAL TENSILE SPECIMENS FROM VACUUM INDUCTION MELT-VAR BILLET



$\overline{X}$ CHART

Upper Control Limit = 262.2
Lower Control Limit = 210.0
$\overline{\overline{X}}$ = 236.1

R CHART

Upper Control Limit = 159.9
Lower Control Limit = 23.5
$\overline{R}$ = 91.7

FIGURE 6-45

CONTROL CHART FOR ULTIMATE STRENGTH OF NOTCHED TRANSVERSE TENSILE SPECIMENS FROM VACUUM INDUCTION MELT-VAR BILLET

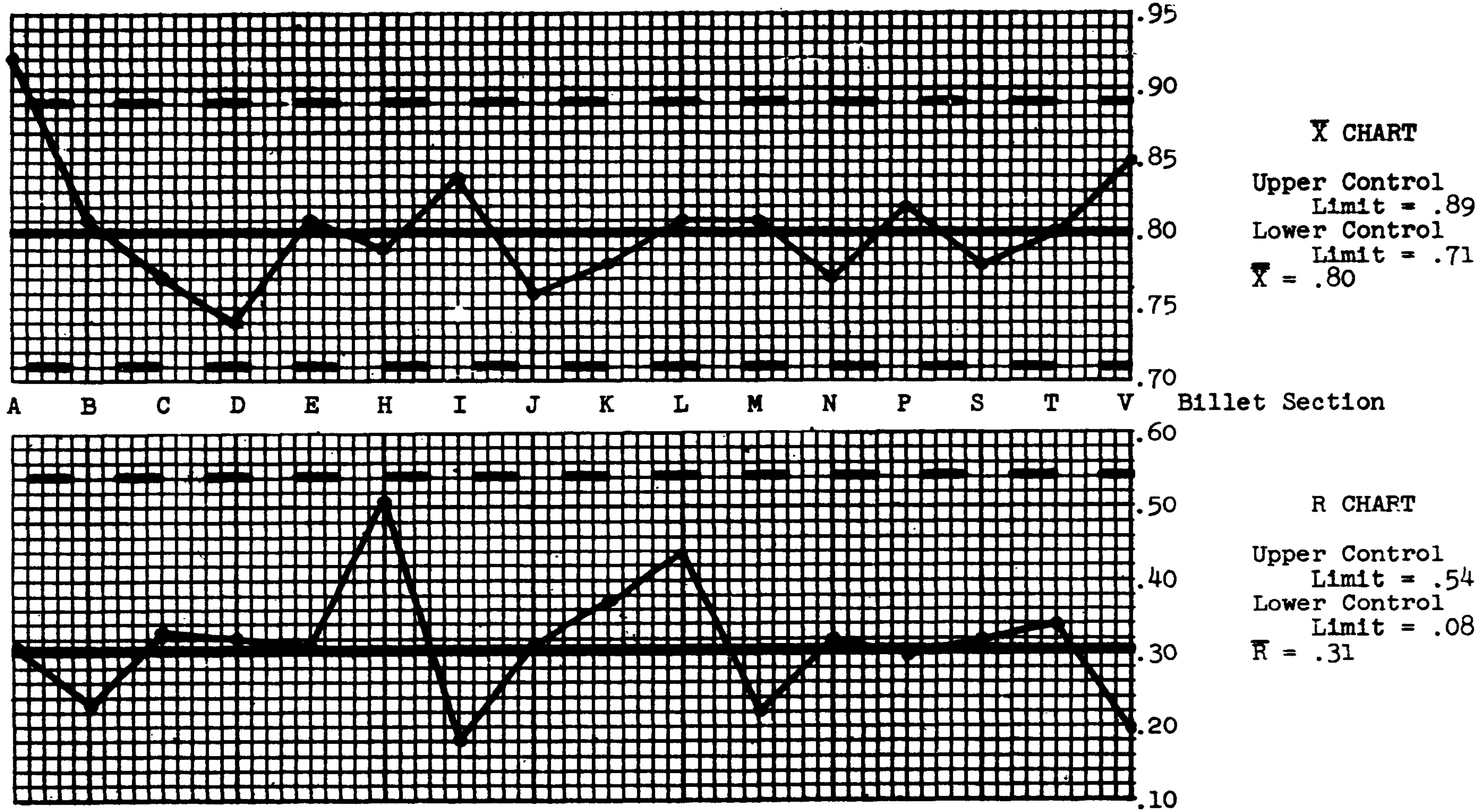


FIGURE 6-46

CONTROL CHART FOR N/S STRENGTH RATIO OF TRANSVERSE TENSILE SPECIMENS FROM VACUUM INDUCTION MELT-VAR BILLET

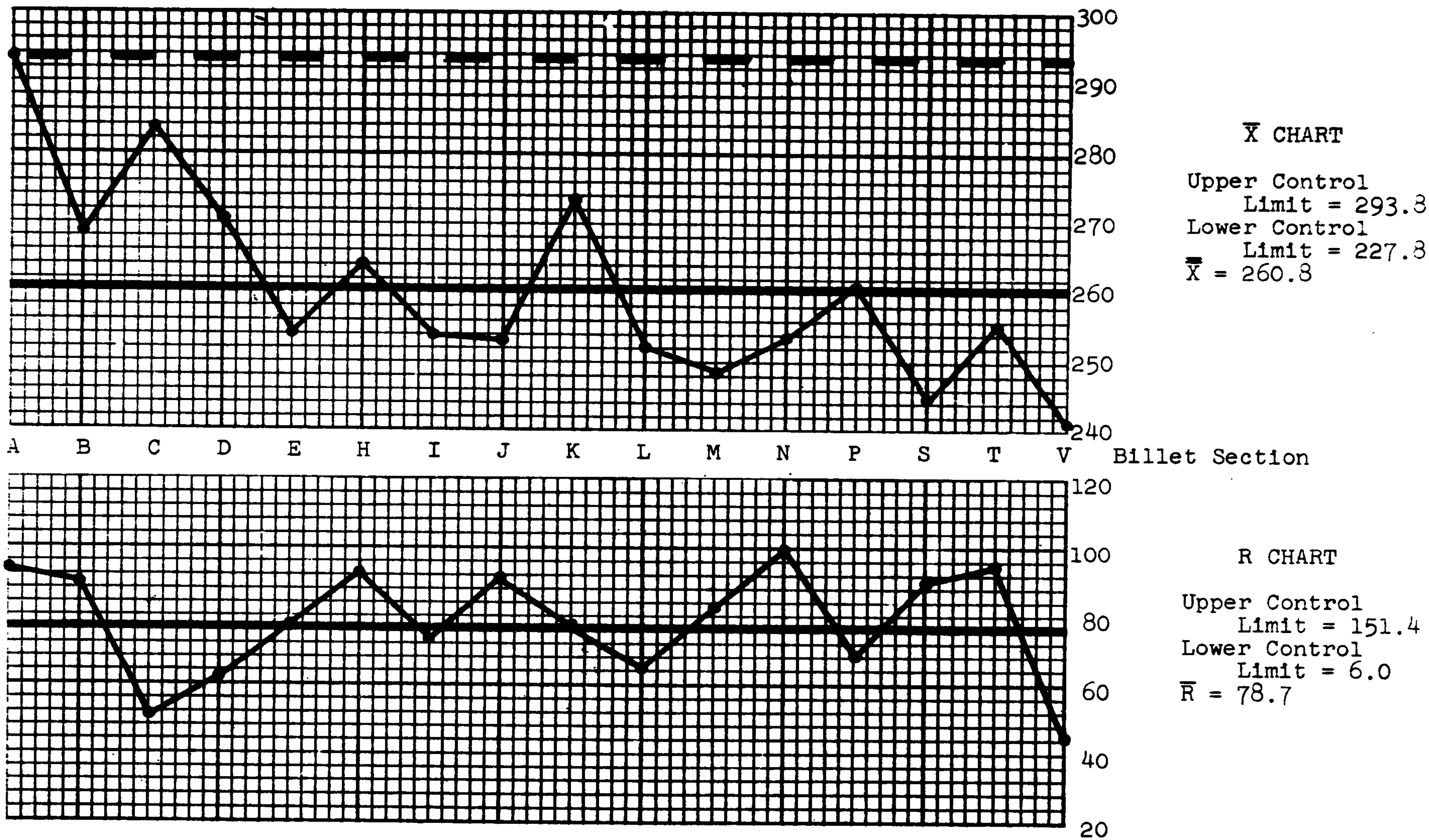


FIGURE 6-47

CONTROL CHART FOR ULTIMATE STRENGTH OF NOTCHED LONGITUDINAL TENSILE SPECIMENS FROM VACUUM INDUCTION MELT-VAR BILLET

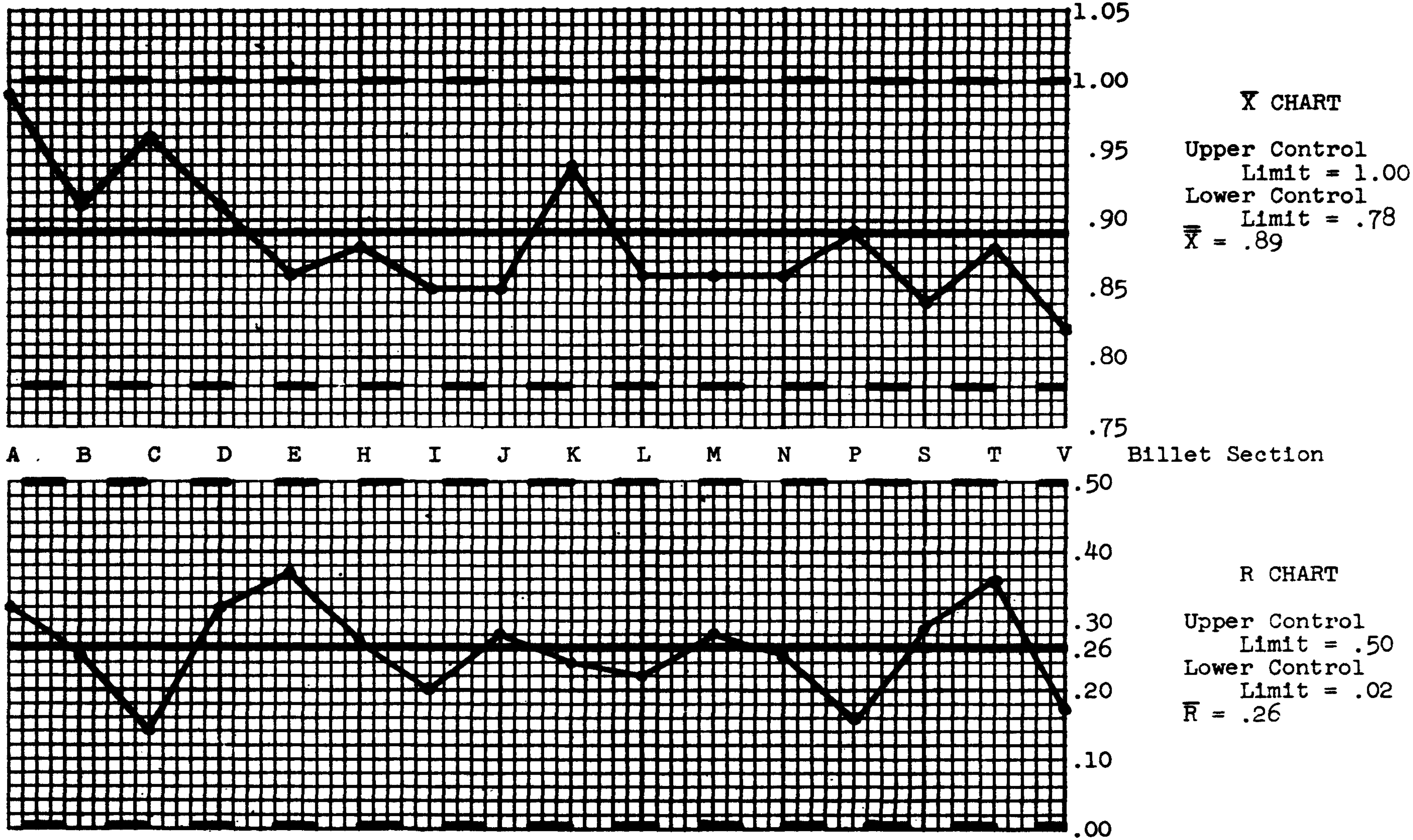


FIGURE 6-48

CONTROL CHART FOR N/S STRENGTH RATIO OF LONGITUDINAL TENSILE SPECIMENS FROM VACUUM INDUCTION MELT-VAR BILLET

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